THE PLANT DISEASE REPORTER

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Crops Research Division serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

COMMONWEALTH MYCOLOGICAL INSTITUTE
19 JAN 1961

SUGGESTIONS FOR PREPARATION OF MANUSCRIPTS FOR THE PLANT DISEASE REPORTER

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ACCEPTANCE OF MANUSCRIPTS

The increase in the volume of pertinent material offered for publication in the Plant Disease Reporter has made it necessary to limit the subject matter and the length of articles accepted. The subject matter should emphasize new things in plant pathology, such as new records of disease occurrence, serious outbreaks and epidemics, conditions affecting development of plant diseases, techniques of investigation including instrumentation, new discoveries in control including new materials and their evaluation. Manuscripts will be limited to 12-double-spaced typed pages, including tables, graphs, and photographs. Because of reproduction costs photographs should be kept to a minimum. Insofar as possible, material should be presented as graphs rather than tables. Papers cannot be accepted for publication that report routine control experiments, reviews, bibliographies without annotation, results of routine surveys, mere summaries or lists of plant diseases. By following this procedure we hope to continue publishing all articles promptly.

Paul R. Miller

Manuscripts for and correspondence about this publication should be sent to:

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NEW TECHNIQUES FOR PLANT DISEASE SURVEYS AND FOR APPRAISAL OF LOSSES[1]

Paul R. Miller[2]

During the past ten years a great many studies have furnished information helpful in estimating losses from plant diseases. Some of the findings are important, but many others possess only limited significance. This report is restricted to major advances in survey methods and to representative examples of the type of investigation that provides bases for estimating or predicting losses. A supplementary annotated bibliography may be found after the Literature Cited.

The discussion is organized under three topics: first, advances in survey methods; second, fundamental investigations on the spread of pathogens; third, assessment of plant disease importance, including loss analysis and sampling methods.

ADVANCES IN SURVEY METHODS

Probably the most important, and certainly one of the most intriguing recent developments in survey techniques, is Colwell's (5) application of aerial photography to wide-scale surveying for diseases of cereal crops. Interpretation of photographs taken according to specifications explained by Colwell permits identification of healthy small grain crops, very early detection of disease infection centers, and accurate estimation of the severity of disease in infected fields. Colwell's report is concerned primarily with detection of stem rust (Puccinia graminis tritici and P. graminis avenae) in wheat and oats respectively, and of the virus disease yellow dwarf in oats. West (18) further expanded the principle, using additional photographic techniques to reveal not only pathogenic disease but nutritional deficiencies in various crops as well.

Perhaps the aerial photo-interpretation method can be further adapted for detection of probable hazard of attack by soil-borne pathogens, but at present only recorded crop history and isolation of the organisms provide a basis for determination of soil-borne inoculum potential. From studies with Fusarium solani f. phaseoli and Thielaviopsis basicola, Maloy and Alexander (11) concluded that the "most probable number" method for estimating populations would be applicable to any soil-borne pathogen, given suitable test hosts and recognizable symptoms, and that it should be of value in many different types of plant disease investigation in which soil-borne organisms are involved. Another approach was reported by Boosalis and Scharen (2), who devised a method for detection of oospores of Aphanomyces euteiches (this is the first record of the finding of oospores of this fungus in a natural habitat) and sclerotia of Rhizoctonia solani by direct microscopic examination of soil samples containing plant debris from infested fields. Numbers of oospores present gave reliable inoculum potential figures for A. euteiches. For estimating inoculum of R. solani, however, it was necessary to develop a method of plating out the fungus from plant debris. According to the authors their method is a step toward prediction of the disease potential of a field, but it needs further refinement.

INVESTIGATIONS ON THE SPREAD OF PATHOGENS

Studies grouped under this heading are concerned with the dynamics of spread or with quantitative methods of measuring or stating disease potential.

Yarwood and Sylvester (20) propose the adoption of the "half-life," which they define "as the time for a homogeneous population to lose one half its activity," as a more correct method of expressing longevity of a plant pathogen than the usual statement in definite periods of time required for complete loss of activity. They give methods of calculation and examples of half-lives of representative pathogens, including viruses, fungi, and nematodes.

Quantity of inoculum is one of the items needed for estimating the probable intensity of spread of a pathogen from a source of infection. Waggoner and Taylor (17) made hourly

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[1] Progress report submitted to the International Commission on Plant Disease Losses (sponsored by UNESCO) and given by title only at the 9th International Botanical Congress, Montreal, Canada. It is published here at the request of the Committee on Agricultural Pests, Agricultural Board, Division of Biology and Agriculture, National Academy of Sciences-National Research Council.

[2] United States Representative, International Commission on Plant Disease Losses and member Subcommittee on Plant Diseases of the Committee on Agricultural Pests.

measurements of the number of spores of Peronospora tabacina per cubic meter in the air over infected tobacco seed beds. Using the statistical theory of turbulence as a basis for calculating, they found that the maximum number of spores disseminated per lesion per day amounted to about 105. Their data showed a diurnal cycle of dispersal, with a maximum in early morning and few or no spores in the air in afternoon and night.

Bega (1) measured quantity and period of telial germination in Cronartium ribicola by determining the number of sporidia cast from telial columns of known size during intervals of time shown by the clocks of rotating drum-type hygrometers.

Conditions associated with 1957 epidemic of wheat leaf rust (Puccinia recondita = P. rubigo-vera tritici) in Kansas, one of the heaviest attacks ever recorded in the State, were very thoroughly documented by the concurrent aerobiological study made by Pady and Johnston (13). Their records of spore deposit, correlated with records of wind direction and velocity, showed very heavy spore showers originating in areas to the south of Kansas. The unusually large amount of inoculum, combined with favorable weather for unusually long periods, resulted in rapid development of leaf rust.

Garrett et al. (6) found that the number of early-season centers of stem rust (Puccinia graminis tritici) developing in a wheat field was a critical factor in reducing yield, bushel weight, and kernel weight.

Field infection by wheat stem rust can be predicted by means of a formula based on dew duration, temperature, and light, according to Sharp et al. (15).

Amount of incipient infection of grapes at harvest time is the basis of a method, reported by Harvey (8), for estimating the extent of decay due to various fungi likely to develop in California storage grapes. Pierson (14) used a similar basis for forecasting development in storage of bull's-eye rots (Neofabraea perennans and Phialophora malorum) of apples grown in the Northwest.

Apparently investigations on the dissemination of air-borne inoculum have not made much use of radioactive substances so far, although radioactivity has been applied to other kinds of phytopathological research. A few papers that have some pertinence to our topic can be cited, however.

Colwell (4) used radioactive phosphorus (P^{32}) to tag pollen grains of Pinus coulteri for an experiment to determine the distance and intensity of dissemination of pollen released from a given point. He recommended the employment of radioactive tagging in work on similar problems, such as, in particular, acquiring the definite spore gradient data needed to determine the probability of dissemination of a plant pathogen to host plants at various distances from the source of infection. He stated the factors to be taken into account when planning the use of radioactive substances, including the extent of the hazard to health offered by the material in the quantities needed, and the proper precautions to be taken in using it; half-life long enough for the purpose of the experiment but not so long as to contaminate the experimental area for an appreciable period afterward; ease with which results can be analyzed by available equipment; care to prevent interference with similar experimental study in the same area; prior determination of natural radioactivity of the spore; effect of the material selected on the viability of the spore; effect of the method of tagging on the "ballistic" characters of the spore, that is, weight, buoyancy, availability, and cost of the material.

Morris et al. (12) used radioactive iodine (I^{131}) for tagging insect vectors of the oak-wilt fungus (Ceratocystis fagacearum) to determine pattern and distance of flight and thus the distance and area of possible dissemination of the pathogen. Hoffman and Zuckerman (9) obtained radioactive ascospores from a strain of Ceratocystis fagacearum labelled with radioactive carbon (C^{14}) and crossed with an unlabelled compatible strain, and inoculated oak seedlings with labelled conidia. Leaves of the inoculated seedlings wilted in 20 days and radioactivity was detected in them. The radioactive carbon did not appear to affect the fungus or the toxin produced by it. Wynd (19) described a method of obtaining virus preparations with sufficient radioactivity for use as measurable reagents when reinoculated into healthy plants. He added radioactive orthophosphoric acid to a low-phosphate nutrient medium in which tobacco plants were grown, and 7 days later he inoculated the plants with a virulent strain of tobacco mosaic virus. Radioactive virus was recovered 62 days after inoculation.

An interesting and different approach to the study of air transport of pathogens was reported by Van Arsdel et al. (16). They used colored smoke to make paths of air movement in a rice paddy visible. Travel of smoke released at different heights and under different environmental conditions was recorded on color film.

ASSESSMENT OF IMPORTANCE OF PLANT DISEASES

Chester (3) made a thorough search of plant pathological literature for methods of measuring and calculating plant disease losses. He explored all aspects of obtaining and utilizing estimates, analyzed the standards on which estimates were based, reviewed sampling methods, and pointed out errors of concept and practice. He employed this analysis to define plant disease loss appraisal as an important field in its own right, in opposition to the usual notion of loss estimates as subsidiary to other phases of plant disease research. Chester's book is the pioneer manual, and so far the only one, on this subject.

One of the problems that must be met in estimating severity of plant diseases is selection of the sampling method suited to the particular investigation. LeClerg (10) gives a helpful explanation of some principles underlying sampling procedures applicable to measuring losses from crop diseases. His discussion covers the concepts of population and variability in the measurements; types of sampling designs, including random, stratified, and systematic sampling; and the factors to be considered in determining the number of samples to be selected.

Since plant diseases constitute only one of many factors in crop production, a realistic appreciation of their importance requires that their effects be considered together with the influence exerted by other conditions. Grafius and Kiesling (7) direct attention to vector analysis as an objective method of representing interaction between plant and environment and of estimating the relative importance of the different environmental conditions. Specifically, they state that the method can be used to describe the severity of an attack by a plant disease and to estimate the importance of the disease as compared with other variables in a given set of data.

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DIFFERENTIAL TRANSMISSION OF NINETEEN VARIATIONS OF STRAWBERRY MOTTLE VIRUS BY APHIS GOSSYPII GLOVER

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Abstract

Aphis gossypii was tested for its ability to transmit 19 variations of the strawberry mottle virus. The species failed to transmit five of the variants, transmitted six at a relative efficiency of about 25 percent and eight at about 50 percent. The results appeared to support previous evidence that the typical and curly-dwarf groups of variants of the virus are distinct.

Strawberry mottle virus was reported by Frazier and Posnette[2] to include a large number of stable variants whose symptoms intergraded and were similar qualitatively but quantitatively appeared to represent three groups designated the typical, curly-dwarf and rusty-leaf forms of the virus. Each group was additionally characterized by vector-virus-plant relationships (acquisition threshold period, virus retention and incubation period) which generally remained consistent among the isolates within each group but differed between the groups. The term isolate was used in a sense synonymous with a specific source plant or an original transmission from which, during subsequent transfers, milder but stable variations of symptom expression sometimes were segregated. The variants of the isolates were classified on the basis of severity of symptom expression, from faint to severe, but the fact was not emphasized that each variant differed from all other variants irrespective of the degree of symptom expression or source (isolate) from which it was segregated. The same authors also confirmed the ability of Aphis gossypii to transmit the virus and suggested that the species was an erratic vector of relatively low efficiency.

Further tests have been carried out with A. gossypii to determine whether the erratic results in the original tests were due to selective transmission among the numerous mottle virus variants that were used (but not cited) as virus sources.

MATERIAL AND METHODS

The identical virus isolates and variants described by Frazier and Posnette[2] and used in their work on strawberry mottle virus at Berkeley were selected for the present tests, along with four other variants of three of the isolates. Alpine indicator plants (a variety of Fragaria vesca) were used both for virus source plants and test plants.

The stock colony of A. gossypii originated on commercial strawberry and was maintained on Alpine plants.

Acquisition feeding periods ranged from 16 to 19 hours and a minimum test feeding period of 20 hours was used. Ten aphids were fed upon each test plant, and five plants were tested from each virus source plant. The experiment was replicated six times for each of the 19 mottle virus variants with a fresh virus source plant used in each replicate. Fresh source plants of the variants not transmitted by A. gossypii were provided by inoculations using Pentatrichopus thomasi Ris Lambers ssp. jacobi Ris Lambers.

RESULTS

Results of the tests are given in Table 1. It is evident that all of the 13 tested variants of the typical group were transmissible. On the other hand, only one of six variants (CD4) of the curly-dwarf group was transmitted, and this inefficiently. There appeared to be three distinct levels of transmission efficiency: approximately 0 percent transmission of the 5 variants of curly-dwarf isolates 1, 2 and 3, 25 percent transmission of the variants M3A, M3B, M3C, M4C, M4D, and CD4, and 50 percent transmission of the variants of typical isolates 1 and 2 and M4A, M4B, and M4E.

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[1]Associate Entomologist, California Agricultural Experiment Station, Berkeley.

[2]Frazier, Norman W., and Adrian F. Posnette. 1958. Relationships of the strawberry viruses of England and California. Hilgardia 27: 455-513.

Table 1. Transmission of nineteen variations of strawberry mottle virus by Aphis gossypii to Alpine test plants using ten aphids per plant, six replicates of five plants, an acquisition feeding period of 16 to 19 hours and a minimum test feeding period of 20 hours.

Strawberry mottle virus			Replicate						Total infected of 30 plants
Group and isolate	Variant	Code name	1	2	3	4	5	6	
Typical									
1	faint	M1A	2[a]	0	4	3	4	3	16
	mild	M1B	5	1	2	2	2	3	15
	intermediate-1	M1C	3	1	3	4	1	5	17
	intermediate-2	M1D	4	0	4	3	2	4	17
2	mild	M2	3	3	4	1	2	5	18
3	mild	M3A	0	0	0	3	3	1	7
	intermediate-1	M3B	0	0	0	2	3	0	5
	intermediate-2	M3C	1	2	0	2	2	0	7
4	faint	M4A	3	3	2	2	4	2	16
	mild	M4B	3	4	1	2	5	1	16
	intermediate-1	M4C	0	2	3	0	2	1	8
	intermediate-2	M4D	2	2	2	1	2	0	9
	severe	M4E	1	3	5	0	1	4	14
Curly-dwarf									
1	severe-1	CD1A	0	0	0	0	0	0	0
	severe-2	CD1B	0	0	0	0	0	0	0
	severe-3	CD1C	0	0	0	0	0	0	0
2	severe	CD2	0	0	0	0	0	0	0
3	intermediate	CD3	0	0	0	0	0	0	0
4	mild	CD4	1	0	1	0	1	1	4

[a] Numbers represent the number of plants infected of five fed upon by aphids.

The association of the virus variants at each of the three levels of transmission seems to be related to the sources and grouping of the variants, and not at random. In this respect the results support the original criteria (differences in symptoms, acquisition threshold periods, periods of virus retention, and incubation periods) used to distinguish the typical and curly-dwarf groups of mottle virus variants. As to the degree of relationship involved among the variants concerned, the significance of the three apparent levels of transmission efficiency is not clear. Perhaps if requisite data were available, a re-grouping of the variants could be made which would provide a more accurate estimate of their natural relationships.

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CONTROL OF CABBAGE CLUBROOT IN NORTH CAROLINA

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Abstract

Terraclor (pentachloronitrobenzene), at rates of 2, 3, or 6 pounds per 100 gallons of transplant water, effectively controlled clubroot of Badger Market cabbage in heavily infested soils. However, when long season varieties such as Oakview were planted under similar conditions only a few plants produced heads of marketable size and quality. Treatment of plant bed sites with 1, 2, or 3 pounds methyl bromide per 100 square feet of plant bed area gave excellent control of both clubroot and wirestem.

Clubroot of cabbage (Brassica oleracea var. capitata), caused by Plasmodiophora brassicae Wor., is a serious problem in commercial cabbage-producing areas in the mountains of North Carolina. The disease is especially prevalent and severe in Watauga and Avery counties, where it is difficult to find non-infested fields for further plantings. Losses have been heavy, and in some individual fields total loss has occurred, hence, many fields have been abandoned for cabbage production.

Growers in the infested areas have not been able to treat the soil with lime and calomel (as suggested (3, 5, 9, 11, 12) for control) since such treatment greatly aggravates the potato scab problem or is otherwise undesirable for potatoes, another important crop commonly grown in the clubroot infested areas of North Carolina.

In recent years several other chemicals have been reported to give satisfactory control of clubroot. These include Terraclor (75 percent pentachloronitrobenzene) (1, 4, 6, 8), chloropicrin (trichloronitromethane) (7), Vapam (31% sodium methyldithiocarbamate) (2), captan (8) and griseofulvin (6).

While no varieties have been released, substantial progress in the development of varieties of cabbage resistant to clubroot has been made (10).

The major objectives of this report were to determine whether PCNB would give adequate clubroot control on several varieties under North Carolina production conditions; to determine whether clubroot resistant lines would perform satisfactorily in western North Carolina; and to obtain a measure of the relative effectiveness of the control methods.

MATERIALS AND METHODS

Tests involving chemicals and/or clubroot resistant lines have been conducted in the field at one or more locations in western North Carolina each year since 1954. In certain years these resistant lines were also planted in eastern North Carolina.

Terraclor (75 percent PCNB) was applied in transplant water at a rate of 1/2 pint per plant of a mixture of 2, 3, or 6 pounds per 100 gallons (0.42, 0.64, and 1.3 g PCNB per plant, respectively). In certain tests preplant treatments with 75 percent PCNB was also applied as a drench with a watering can at rates of 32 and 74 g per 50 square feet, in a band 1-foot wide. Such treatments were worked into the soil with a rototiller and will be referred to in this report as broadcast row treatments. PCNB treatments were applied in the transplant water, or broadcast treatments were applied: 1) 2 weeks prior to transplanting; 2) just prior to transplanting; 3) as a split application with one application applied just before transplanting and a second at mid-season or just before the cabbage began to head. Rates, unless stated otherwise, represent quantities of the commercial formulation. Plots were 50 feet in length. Cabbage plants grown in clubroot free soil were transplanted 1 foot apart. Four 50 plant replicates of each treatment were used. Tests were repeated in two or more locations each year.

Methyl bromide (bromoethane) treatments were applied at rates of 1, 2, and 3 pounds per 100 square feet of plant bed area in clubroot infested land. Methods used were similar to those currently recommended in North Carolina for the control of damping-off in pepper plant beds (13).

Roots were rated, using the following scale: 0 -- no galls; 10 -- very few small galls on secondary roots; 25 -- moderate number of small galls on secondary roots, or one moderate or small gall on the tap root; 50 -- moderate galling with a few moderate to large galls; 100 -- severe galls; large galls on taproot and on several secondary roots.

Table 1. The effect of soil treatments with 75 percent PCNB and resistant lines on severity of clubroot development in cabbage grown in heavily infested soil in western North Carolina.

Variety, treatment, rate[a] and method of application	Average clubroot disease index				
	Location B		Number of plants with heads by Sept. 18[b]	Location A	
	July 26	Aug. 29		July 25	Aug. 28
Wisconsin Line 192255L Nontreated	1	9	113	1	8
Oakview					
Nontreated	53	80	0	32	63
Transplant water[c]					
2 lbs./100 gal.	5	48	39	4	47
3 lbs./100 gal.	3	37	38	3	38
6 lbs./100 gal.	4	49	11	4	35
3 lbs./100 gal. plus broadcast[d]	6	51	22	4	49
Broadcast at transplanting[e]					
32g/50 sq. ft.	30	72	4	13	50
64g/50 sq. ft.	23	69	5	14	52
32g/50 sq. ft. plus broadcast[d]	50	82	2	18	56
Broadcast 5/29					
32g/50 sq. ft.	11	52	7	11	34
64g/50 sq. ft.	7	45	19	19	46
L.S.D. .05	15	12		11	19
.01	21	17		14	26

[a] Rates represent quantities of commercial formulation.
[b] Number of plants, out of 150, which formed heads suitable for market.
[c] Applied in 1/2 pint of water per plant (2, 3, and 6 pound rates are equivalent to 0.42, 0.64, and 1.3 g PCNB per plant).
[d] Applied as a drench and mix in a 1-foot band with a rototiller prior to transplanting.
[e] Sidedressing applied as a drench on July 25 or 26.

EXPERIMENTAL RESULTS

Field Tests: In most of the field studies, Oakview, the most widely grown variety in western North Carolina, was used as the clubroot susceptible variety. Certain clubroot resistant breeding lines obtained from J. C. Walker, University of Wisconsin, Madison were included in these tests. In most cases the line 192255L was used.

When Oakview cabbage was planted in heavily infested soils, treatments with PCNB appeared to be quite promising at midseason (July 25, 26; Table 1), particularly when applied in the transplant solution. Roots of all the Oakview plants were severely clubbed by the time of harvest (Sept. 18). The most heads harvested from any of the Terraclor (PCNB) treatments was 39 while 113 heads of Wisconsin Line 192255L which had received no chemical treatment were harvested. None of the non-treated susceptible plants formed heads, in fact, most plants were dead by this time. Although many of the Wisconsin 192255L plants were affected with clubroot by August 29 and September 18, galls were always small and few in number and were found only on the secondary roots. The results given in Table 1 are typical of those obtained from research or demonstration tests planted in fields heavily infested with the clubroot organism.

In certain tests Oakview cabbage was planted on land which had not been planted to cabbage for several years or in which the infestation was moderate to light in the preceding cabbage crop. Under these conditions plants treated with PCNB always appeared vigorous about 6 weeks after transplanting. Small galls were usually present on secondary roots and occasionally on the tap roots at this time. Non-treated plants at the same stage were frequently

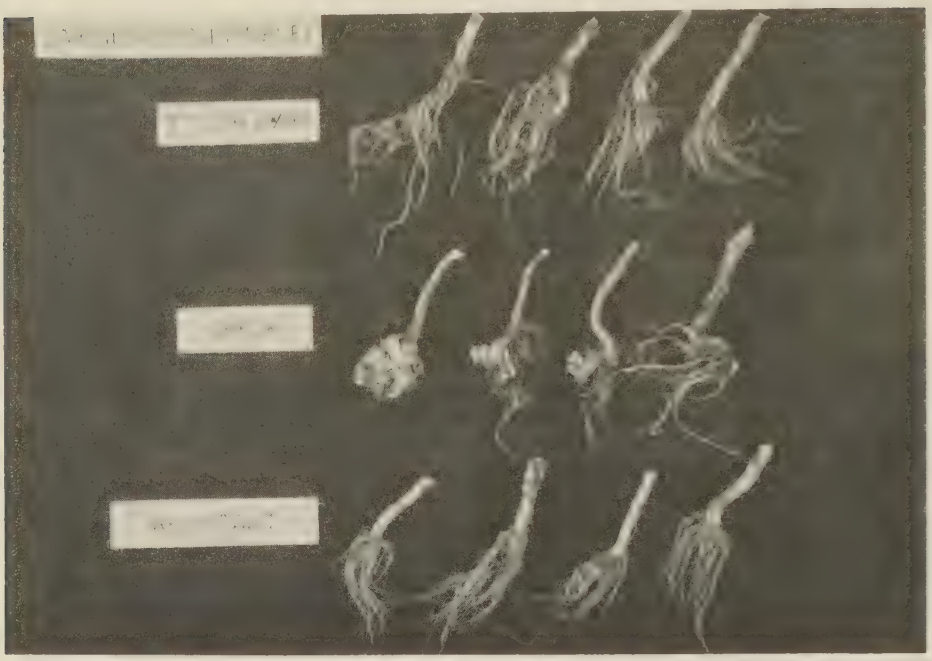

FIGURE 1. Susceptible Oakview plants treated with Terraclor (PCNB); non-treated Oakview plants and non-treated resistant Wisconsin 192255L plants.

severely galled and resistant lines were usually free of galls. Plants from such a test are illustrated in Figure 1. Usually 75 percent or more of the treated plants produced marketable heads, whereas in non-treated plots usually less than 50 percent of the plants formed heads.

Badger Market, a short season variety, was used in some tests nontreated and with PCNB in transplanting water. Most of the treated plants of this variety produced marketable heads even in severely infested plots. From 10 to 100 percent of the non-treated plants in such tests failed to produce marketable heads.

Plant Bed Treatments: The effectiveness and economic value of field soil treatments is markedly reduced when infected transplants are set into the field. Coincident with the continued planting of cabbage on infested farms has been the spread of clubroot to formerly non-infested fields. For many farmers non-infested plant bed sites are not available. Hence, tests were run to determine whether methyl bromide treatments would result in the production of clubroot free transplants. Seed beds were prepared and treated under plastic with 1, 2, or 3 pounds of methyl bromide per 100 square feet of plant bed area. Non-treated plots were seeded as checks. Seeds of the susceptible variety Oakview and clubroot resistant line 192255L were sown. In one location beds were seeded on May 22 and disease readings were made on July 26. In a second location beds were seeded June 5 and disease readings were made August 29.

In the first test no clubroot diseased plants were observed in any of the plots treated with methyl bromide. In the non-treated check plots all plants of the line 192255L appeared healthy while in each of the three check plots 85 to 90 percent of the Oakview plants had clubroot. Approximately 50 percent of these were severely affected. Roots of plants taken from a 1 pound methyl bromide per 100 square feet plot treatment and a non-treated plot are shown in Figure 2.

Between 40 and 50 percent of the plants taken from the non-treated plots were also affected with the wirestem disease incited by Rhizoctonia solani Kuehn. No plants affected with wirestem were observed in any of the methyl bromide treated plots. Furthermore, no weeds were present in the methyl bromide plots. With a few exceptions the results obtained were essentially similar in the second test in which only susceptible Oakview was planted. No infected plants were observed in the treated plots in late July. However, by August 29, a few clubroot infected plants were found in the methyl bromide treated beds (from 1 to 4 percent).

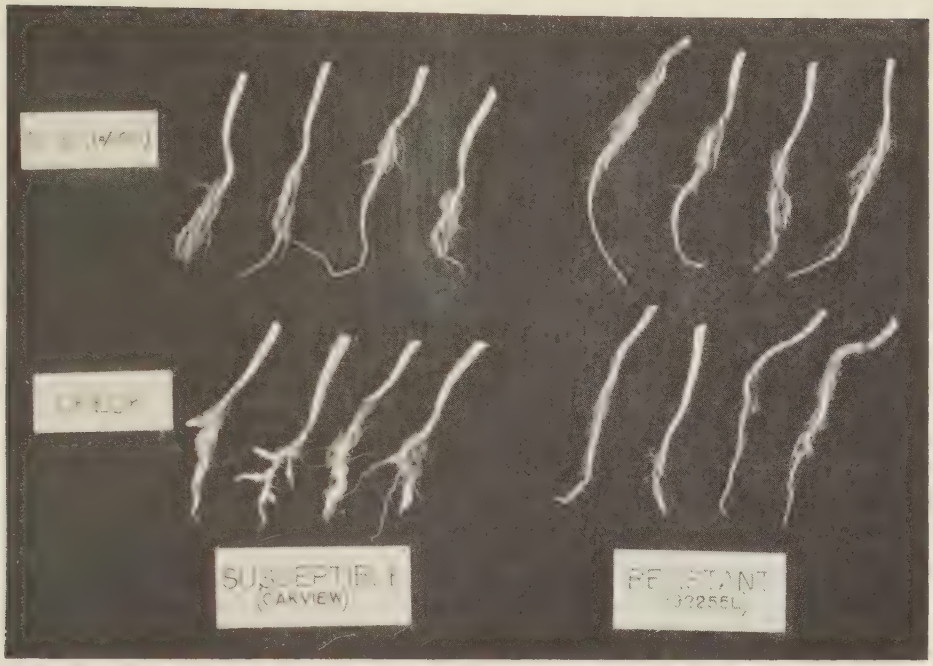

FIGURE 2. Susceptible Oakview and resistant Wisconsin 192255L plants grown in non-treated and methyl bromide treated seed beds.

In each case no more than one infected secondary root was observed on any plant and diseased plants were located near the edge of the bed suggesting reinfestation. No wirestem was observed in the treated plots, and no plants were alive by this date in the non-treated plots. In each of these tests, as well as in subsequent demonstration tests, the 1-pound rate has appeared effective in the control of both clubroot and wirestem in cabbage seed beds.

DISCUSSION

While clubroot ratings were quite high at some locations for the PCNB treatments, this material, as previously reported (1, 4, 6, 8), showed considerable promise in the control of clubroot. Usually at harvest time the ratings of roots did not give a true picture of the value of PCNB. Clubroot indices on susceptible varieties at this time were very high irrespective of treatment, rate, or method of application. However, top growth and heading of the susceptible variety receiving PCNB was definitely superior to that of the susceptible variety receiving no treatment.

In heavily infested fields treatment did not always result in sufficient clubroot control. This was especially true when a long season variety such as Oakview (110 days) was planted. However, when varieties such as Badger Market (70 days) were planted, control with PCNB treatments, while not complete, was usually adequate for the production of a successful crop. Successful cabbage production apparently also may be accomplished on clubroot infested soils when PCNB treatment is coupled with an adequate rotation, even with long season varieties such as Oakview.

While clubroot resistant varieties are not currently available for use in infested areas, the performance of such lines in these tests indicates that resistant varieties offer by far the best method of clubroot control. Consumer acceptance tests in grocery stores and taste panels comparing resistant lines with commercial varieties both as cooked cabbage and as slaw indicate that the resistant lines currently available compare favorably with other varieties.

Methyl bromide treatment of plant beds appears to offer considerable promise to cabbage growers. It was effective at the 1-pound rate not only for control of clubroot, but also for control of wirestem and weeds. If precautions previously outlined (13) are followed it will also eradicate root-knot nematodes from the plant bed site and should be of considerable value to North Carolina cabbage plant growers.

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RICE DISEASES IN THE DELTA AREA OF MISSISSIPPI IN 1959

H. W. Johnson and H. R. Caffey[1]

Diseases have been unimportant during the 10 years that rice has been grown commercially in the Delta Area of Mississippi. However, in 1959 rather severe outbreaks of three diseases were observed. In late August, approximately half of the heads were ripening prematurely in a field of Nato rice north of Greenville, Mississippi. This was the second successive rice crop on this land, the first having yielded well. Affected plants had dark brown lesions on the culm (Fig. 1) and branches of the panicle resembling blast, or rotten neck, caused by the fungus Piricularia oryzae. Culm sections bearing lesions were placed in a moist chamber, and P. oryzae spores were produced in abundance. Leaves of diseased plants were free of leaf spots when observed. Loss to the grower was estimated to be 35 to 50 percent.

In late September both leaf smut (Entyloma oryzae, Fig. 2) and kernel smut (Neovossia barclayana, Fig. 3) were observed in a field of Bluebonnet 50 rice near Ruleville, Mississippi. Leaf smut was observed also in a field of this variety near Cleveland, Mississippi. The losses in these fields were negligible when compared with the loss in the field attacked by P. oryzae. However, diseases are apparently becoming more prevalent in the Delta Area of Mississippi as more crops of rice are grown.

FIGURE 1. Culms of Nato rice showing healthy culm (left) and four culms with lesions of neck rot caused by Piricularia oryzae.

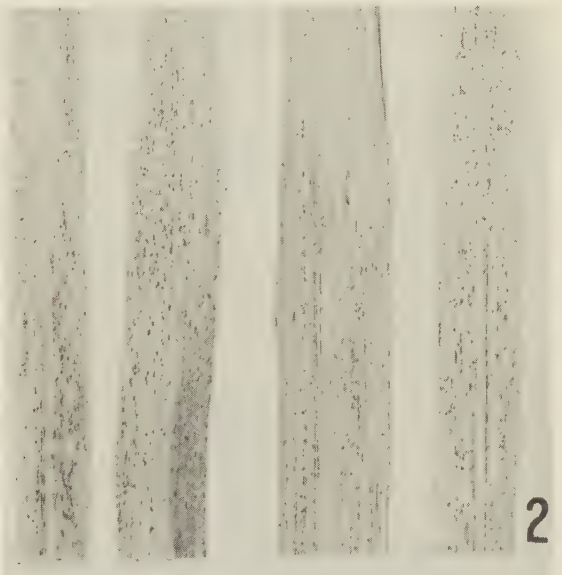

FIGURE 2. Leaves of Bluebonnet 50 rice showing small black sori of the leaf smut fungus (Entyloma oryzae).

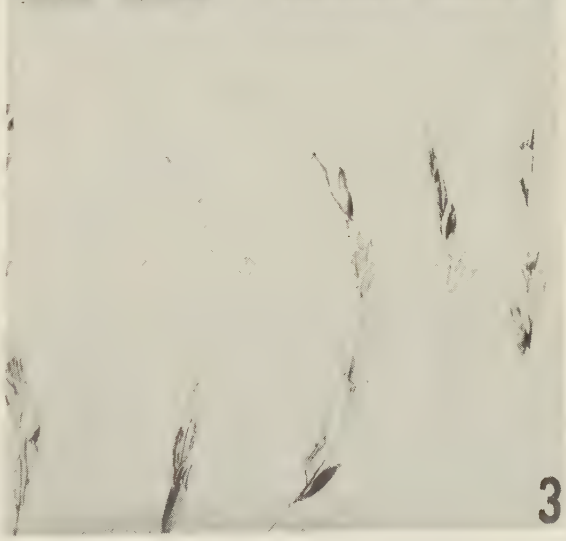

FIGURE 3. Panicle branches of Bluebonnet 50 rice showing black spore masses of the kernel smut fungus (Neovossia barclayana).

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[1] Research Pathologist and Agronomist, respectively. Cooperative work of Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and Mississippi Agricultural Experiment Station.

RUSTY SPOT OF PEACH AND ITS CONTROL IN NEW JERSEY[1]

Robert H. Daines, C. M. Haenseler[2]
E. Brennan and I. Leone[3]

Abstract

Rusty spot, a tannish spot on peach fruits described by Sprague in 1955, has been observed in New Jersey orchards during the past 4 years particularly on Rio Oso Gem, Goldeneast and Summer Queen varieties. Although Sprague reported no evidence of fungi, mycelial strands have been repeatedly observed on the young spots in New Jersey. The presence of fungal hyphae and mildew-like spores, together with the facts that the lesion bears some resemblance to old powdery mildew lesions, that it is most prevalent in the vicinity of mildew-infected apple orchards, and that it can be controlled by sulfur fungicides known to be effective against powdery mildew, is highly suggestive that rusty spot in New Jersey is caused by one of the powdery mildews.

In 1956 Sprague and Figaro[4] described a tannish spot on peach fruits, somewhat resembling old powdery mildew infections, which they called "rusty spot." The spots exhibited tannish hairs that were soon shed, producing a bald area with a rough lignified surface. Since histological studies showed no evidence of fungi, Sprague decided that the spots were not sterile mildew lesions.

What appears to be a very similar or identical disease has been observed in peach orchards in many sections of New Jersey during the past 4 years. To date the disease has been observed only on the Rio Oso Gem, Goldeneast, and Summer Queen varieties, but no thorough survey has been made to determine varietal susceptibility. One hundred percent of the fruits were affected in a few blocks of Rio Oso Gem and Goldeneast.

To the naked eye the earliest appearing symptom is a small orange-tan spot, 3 to 5 mm in diameter, on young, green fruit (Fig. 1). As the disease progresses, the margin of the lesion advances in the form of a ring, leaving a somewhat smooth center. Finally, the lesion becomes less circular, spreads out indeterminately, and the central portion is covered with reddish scales (Fig. 2).

The disease has been studied in New Jersey for the past 3 years, both in the laboratory and in field spray control experiments.

Histological examination was made of cross sections of peach skin at the various stages of rusty spot development. Observation of healthy cross sections established the following norms: epidermal hairs abundant and colorless, absence of mycelial strands, and absence of corky tissue. In the small orange lesion there was an abundance of epidermal hairs; however, they were colored yellow to deep red, thus giving the characteristic color to the lesion. Without exception, mycelial strands were always found in this type of lesion. Aniline blue dye in chloral hydrate was very effective in demonstrating the fungal strands (Fig. 3). Examination of hair scrapings under the microscope revealed occasional mildew-like spores. As the lesion developed -- leaving a smooth center -- epidermal hairs were found in the outer ring but were absent in the central bald portions. Mycelia could not be demonstrated at this stage. As the ring enlarged, hairs disappeared entirely and layers of suberized periderm cells were observed which imparted the reddish scaly appearance.

FIELD TRIALS

Of the fungicide trials conducted, those in 1958 and 1959 are of particular interest. In earlier trial plots on Goldeneast peaches, rusty spot was not uniformly distributed throughout the block. The disease was abundant on the first four or five rows adjacent to a powdery mildew-infected apple orchard. Beyond these rows the incidence of rusty spot decreased as the distance from the apple orchard increased.

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[4]Sprague, Roderick, and Peggybeth Figaro. 1956. Rusty Spot, powdery mildew, and healthy skin of peach fruits compared histologically. (Abst.) Phytopathology 46: 640.

FIGURE 1.
Peach fruit showing early orange-tan lesion characteristic of rusty spot.

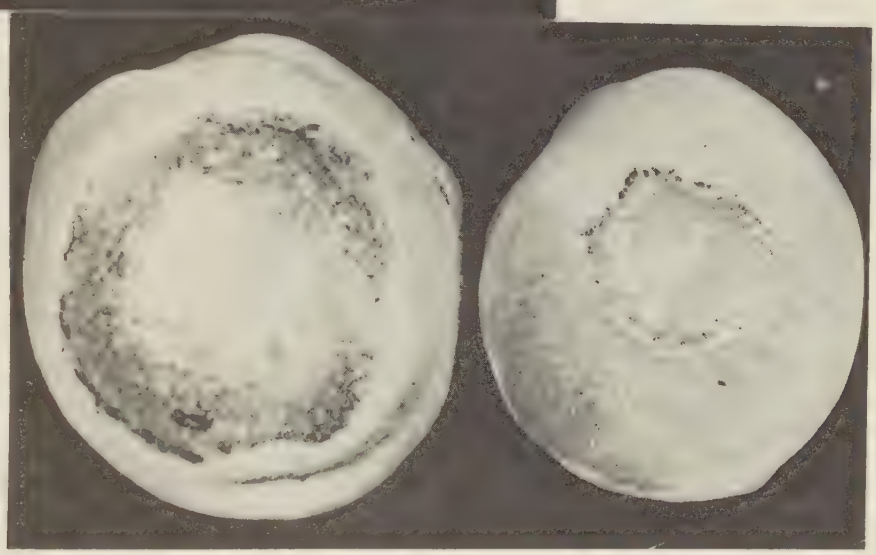

FIGURE 2.
Peach fruit showing advanced stages of rusty spot development.

Table 1. Effect of fungicides on occurrence of rusty spot on fruit of Goldeneast peaches.

Treatment (pounds/100 gallons)	Percent of fruits showing rusty spot	
	1958[a]	1959[b]
1. Wettable Sulfur 5	9.8	15.2
2. Wettable Sulfur 5 + sticker	---	11.2
3. Wettable Sulfur 2 1/2, captan 1	14.4	25.7
4. Captan 2	38.2	38.4
5. Glyodin 1 quart	37.1	--
6. Thiram 2	39.2	--
7. Zineb 2	41.3	--
8. Ziram 2	42.7	--
9. Check unsprayed	43.7	--
L.S.D. 5 percent	6.0	6.9
1 percent	8.2	9.7

[a] Applied May 13 (shuck-split), 22, 28 and June 5.
[b] Applied May 13, 18, 26, and June 8.

FIGURE 3. Photomicrograph of cross section of rusty spot lesion on peach skin, showing fungus mycelia interspersed among the epidermal hairs.

In 1958 and 1959 the spray trial plots were limited to the first four rows adjacent to and running parallel with this same apple orchard. Again, rusty spot was more prevalent in rows closest to the apple trees and became progressively less abundant as one proceeded farther into the block.

The 1958 spray test consisted of four applications of various fungicides (Table 1), each applied to six randomized single-tree plots. The spray applications were begun at shuck-split and continued on an 8 to 10-day schedule. This test was repeated in 1959, using sulfur, captan, and a combination of the two.

Rusty spot was first observed 13 days after the shuck-split application was made. Counts taken of the number of infected fruits in 1958 and 1959 are presented in Table 1. Sulfur treatments provided good protection against rusty spot, but the other materials used gave little or no control.

These studies indicated that rusty spot, as it occurs in New Jersey, is caused by a pathogen which is able to attack and kill the surface cells of the peach fruit but which is unable to sporulate freely on the dead host cells. Similar phenomena are not uncommon in certain powdery mildews on resistant (hypersensitive) varieties.

The following observations would seem to suggest that rusty spot of peach as it occurs in New Jersey may be caused by one of the powdery mildew fungi: 1) rusty spot somewhat resembles old lesions produced by the common peach mildew fungus (Sphaerotheca pannosa); it differs from the latter mainly in being more bald, causing more host cell necrosis, and in sparsity of fungus hyphae and sporulation; 2) a network of hyaline hyphae and occasional spores have been repeatedly observed on the surface of young spots; 3) rusty spot is most prevalent in the near vicinity of mildew-infected apple orchards; and 4) sulfur fungicides known to be effective in the control of powdery mildews also control rusty spot.

While these observations are highly suggestive, further studies are necessary to determine definitely the etiology of rusty spot.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION, NEW BRUNSWICK

AN INVERSE RELATIONSHIP BETWEEN THE SEVERITIES OF HELMINTHOSPORIUM LEAF-BLADE AND SEPTORIA LEAF-SHEATH SYMPTOMS ON BARLEY[1]

D. J. Morton and G. A. Peterson[2]

Summary

Barley plants inoculated with Helminthosporium sativum (H. sorokinianum) approximately 2 weeks before heading developed severe blotches on the leaf blades. These same plants showed significantly fewer Septoria lesions on the leaf sheaths at harvest than did non-inoculated plants. The basis for this antagonistic relationship between the diseases has not been established.

INTRODUCTION

Two of the most economically important barley diseases in North Dakota are spot blotch, caused by Helminthosporium sativum Pam., King and Bakke (Helminthosporium sorokinianum Sacc.), and Septoria leaf blotch, caused by Septoria passerinii Sacc. Experiments were conducted at Fargo to study methods of inoculating with H. sativum. Observations on subsequent spot blotch and natural Septoria leaf blotch showed an apparent inverse relationship between severities of the two diseases.

MATERIALS AND METHODS

Seedings of the barley variety Traill were made on April 30, 1959 and eight replications of each treatment were included. Each plot consisted of five rows 5 feet in length with a spacing of 1 foot between rows. Disease data were obtained from the middle row of each plot.

Spore suspensions of H. sativum were applied to the middle row of each plot about 2 weeks before heading. Two methods of application were compared, a light spray and a pressurized spray, and both were applied with a Myers Wheel-Barrow Sprayer. Control plots were not inoculated. Observations were made of spot blotch development in all treatments. Relatively cool, humid weather prevailing for several days after inoculations appeared to favor disease development.

Leaf sheath symptoms of a natural epiphytotic of Septoria leaf blotch were evaluated on all plots at maturity. An index ranging from one (no or very slight symptoms) to five (severe symptoms) was used, and each plot value was derived as an average of three readings taken within the row -- one at each end and one at the middle. The analysis of variance and Duncan's Multiple Range Test were computed for the Septoria leaf blotch data.

RESULTS

Heavy spot blotch development occurred on the leaf blades in all of the inoculated plots, and slightly more lesions were noticed where the pressurized spray had been used than where a light spray was applied. Symptoms were absent or very light, however, on the leaf sheaths. Control plots developed only light spot blotch from natural infections.

The Septoria leaf sheath readings of the control, light-sprayed, and pressurized-sprayed plots are presented in Table 1. A significant difference among treatments was obtained with the analysis of variance. Application of Duncan's Multiple Range Test indicates that the average reading of the control plots is significantly higher than the inoculated treatments at the 1 percent level. The light-spray method of inoculation gave significantly higher values than the pressurized-spray method at the 5 percent but not at the 1 percent level of significance.

DISCUSSION

An apparent inverse relationship in severity was observed between spot blotch on leaf blades inoculated about 2 weeks before heading and Septoria leaf blotch on leaf sheaths of these same

[1]Supported by a grant from the Malting Barley Improvement Association and published with the approval of the Director of the North Dakota Agricultural Experiment Station.

[2]Assistant Plant Pathologist and Assistant Agronomist, respectively, North Dakota Agricultural Experiment Station, Fargo.

Table 1. Sheath readings of Septoria leaf blotch on H. sativum-inoculated barley plants[a].

Treatment	Replication								Av.	*[b]	**[b]
	1	2	3	4	5	6	7	8			
Control	5.0	5.0	5.0	5.0	4.7	5.0	5.0	5.0	4.96	a	a
Light-spray inoc.	4.0	5.0	4.0	4.0	3.0	4.0	4.0	5.0	4.12	b	b
Pressure-spray inoc.	4.0	3.3	3.7	3.3	3.0	4.0	3.7	4.0	3.62	c	b

[a]Readings based on a scale of 1 (no or very light symptoms) to 5 (severe symptoms).
[b]Treatment averages not followed by the same letter are statistically significant at the 5% (*) or 1% (**) level, according to Duncan's Multiple Range Test.

plants at maturity. The reason for this relationship has not been established. A possible explanation is that the necrotic, H. sativum-infected leaf blades were relatively unsuitable for early Septoria infections, thereby providing a lower inoculum potential for subsequent Septoria leaf-sheath infections. However, this is not likely since Septoria leaf-blade infections symptoms were very light on all treatments, and probably contributed little to leaf-sheath infections. Also, the middle row of each H. sativum-inoculated plot was in close proximity to the other, non-inoculated rows, so Septoria inoculum from neighboring rows should have been available for sheath infections.

Another possible explanation of these results is that susceptibility to Septoria leaf sheath infection was reduced by an early senescence associated with plants showing severe spot blotch. However, it has been observed that early-seeded spring barley approaching senescence in early August has a greater development of Septoria leaf sheath symptoms than later-seeded, less mature barley at the same date. In addition, early-maturing barley varieties develop more extensive Septoria leaf-sheath symptoms than do later-maturing varieties seeded on the same date. Therefore, it seems unlikely that early senescence induced by spot blotch development was responsible for the reduced Septoria leaf blotch symptoms.

There is a possibility that spot blotch lesions in the leaf blades might result in the production of substances which, when translocated to the leaf sheaths, would reduce their susceptibility to Septoria leaf blotch; however, there is no evidence available to support this suggestion.

The observations reported here are based on results obtained in the field in 1959. Further studies on the relationship between these diseases are planned.

NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION, FARGO

RESULTS OF REGIONAL SEED-TREATMENT TESTS FOR THE CONTROL OF SEED-BORNE AND SOIL-BORNE COMMON BUNT OF WINTER WHEAT IN THE PACIFIC NORTHWEST, 1959[1]

Laurence H. Purdy[2]

Summary

Twenty-one different chemical formulations were tested as seed treatment for the control of common bunt in the Pacific Northwest. Results were obtained from seven plots in Idaho, Montana, Oregon, Utah, and Washington. Included in the tests were 9 mercurials, 8 formulations of HCB, 2 formulations of PCNB, and 2 experimental non-mercurials. The results at the seven locations were similar.

Good control of seed-borne bunt was obtained with all materials except one formulation of PCNB. Only HCB formulations controlled bunt that originated from soil-borne spores, except for one PCNB formulation that was effective in controlling soil-borne bunt in one type of test. The mercurials failed to control soil-borne bunt.

INTRODUCTION

Regional seed-treatment tests for the control of seed-borne and soil-borne common bunt of winter wheat (Tilletia caries (DC.) Tul. and T. foetida (Wallr.) Liro) have been conducted in the Pacific Northwest for 5 years, 1955 through 1959. In these tests the efficacy of candidate fungicides was evaluated under different environmental and management conditions. The results from these tests have served a dual purpose by being the basis for region-wide seed-treatment recommendations and also a means for checking the stability of the different formulations and active ingredients of the various fungicides. Continued good performance equal to or better than the established standard seed-treatment fungicides on a region-wide basis is essential for a fungicide to qualify as a recommended material for bunt control. Almost all materials included in the 1959 tests were of immediate commercial interest and available on the open market. Certain experimental formulations that had performed well in screening tests were also included in the regional tests.

MATERIALS AND METHODS

Twenty-one different chemical formulations were tested at eight locations[3] in the Pacific Northwest in Idaho, Montana, Oregon, Utah, and Washington. Because of an excessive amount of volunteer wheat in the plot at Worley, Idaho, valid results were unobtainable. The materials tested along with their active ingredients, as reported by the manufacturers, whose names also are listed, are as follows:

Anticarie 40 -- 40 percent hexachlorobenzene. H. P. Rossiger Company, Inc.
Anticarie 80 -- 80 percent hexachlorobenzene. H. P. Rossiger Company, Inc.
Ceresan M -- 7.7 percent N-(ethylmercuri)-p-toluenesulfonanilide. E. I. du Pont de Nemours & Co.
Ceresan 75 -- 2.8 percent ethylmercury 2,3-dihydroxypropyl mercaptide and 0.6 percent ethylmercury acetate. E. I. du Pont de Nemours & Co.
Chemagro C-272 -- 50 percent wettable powder, composition unknown. Chemagro Corp.
Chemagro D-113 -- 50 percent 1,2-dichloro-1-(methylsulfonyl) ethylene. Chemagro Corp.

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[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Agricultural Experiment Stations of Idaho, Montana, Oregon, Utah, and Washington. Scientific Paper No. 1900, Washington Agricultural Experiment Station, Pullman, Washington.

[2]Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, Pullman, Washington.

[3]Grateful acknowledgment is extended to the cooperators who assisted in these tests at the indicated locations: Bozeman, Montana (Dr. E. R. Hehn); Kalispell, Montana (W. W. Mauritson); Moscow, Idaho (Dr. W. K. Pope); Worley, Idaho (E. W. Bitters); Moro, Oregon (W. E. Hall); Pendleton, Oregon (Dr. C. R. Rhode); Logan, Utah (Dr. W. G. Dewey); Lind, Washington (W. L. Nelson).

Chipcote 25 -- 5.41 percent methylmercury nitrile. Chipman Chemical Company, Inc.
Chipcote 75 -- 1.85 percent methylmercury nitrile. Chipman Chemical Company, Inc.
Emmi -- 10.34 percent 1,4,5,6,7,7,-hexachloro-N-(ethylmercuri) bicyclo (2.2.1) hept-5-ene-2,3-dicarboximide. Velsicol Corp.
Monsanto Liquid PCNB -- 35.9 percent pentachloronitrobenzene. Monsanto Chemical Co.
No Bunt 40 -- 40 percent hexachlorobenzene. Chipman Chemical Company, Inc.
No Bunt 80 -- 80 percent hexachlorobenzene. Chipman Chemical Company, Inc.
Ortho L M Seed Protectant -- 2.25 percent methylmercury 8-hydroxyquinolate. California Spray-Chemical Corp.
Ortho L M Seed Protectant (Concentrate) -- 7.5 percent methylmercury 8-hydroxyquinolate. California Spray-Chemical Corp.
Ortho L M Seed Protectant (Dry) -- 5.7 percent methylmercury 8-hydroxyquinolate. California Spray-Chemical Corp.
Panogen 15 -- 2.2 percent cyano (methylmercuri) guanidine. Panogen Company Division, Morton Chemical Co.
Panogen E-15019B -- 25 percent pentachloronitrobenzene. Panogen Company Division, Morton Chemical Co.
Sanocide -- 40 percent hexachlorobenzene. California Spray-Chemical Corp.
Smut Go 40 -- 40 percent hexachlorobenzene. Miller Products Co.
Smut Go 80 -- 80 percent hexachlorobenzene. Miller Products Co.
Stauffer HCB-40 -- 40 percent hexachlorobenzene. Stauffer Chemical Co.

Table 1. Mean percentages of bunt from seven regional seed treatment tests for the control of SEED-BORNE common bunt of winter wheat in the Pacific Northwest, 1959.

Treatment	Form[a]	Ounces per bushel	Mean percentage of bunt	Statistical significance
Check - untreated	-	-	77.6	
Panogen E-15019B	L	2	11.7	
No Bunt 40	W	1	2.0	
Monsanto Liquid PCNB	L	2	1.6	
Stauffer HCB-40	W	1	1.5	
No Bunt 80	W	1/2	1.3	
Emmi	L	1/4	1.1	
Anticarie 80	W	1/2	0.8	
Chipcote 25	L	1/4	0.8	
Chemagro D-113	W	2	0.7	
Smut Go 40	W	1	0.5	
Sanocide	W	1	0.5	
Chemagro C-272	W	2	0.4	
Smut Go 80	W	1/2	0.3	
Anticarie 40	W	1	0.3	
Ortho L M Seed Protectant	L	3/4	0.2	
Chipcote 75	L	3/4	0.2	
Panogen 15	L	3/4	0.2	
Ceresan M	W	1/2	0.1	
Ortho L M Seed Protectant (Concentrate)	L	1/4	0.1	
Ceresan 75	L	3/4	0.07	
Emmi	L	1/2	0.06	
Ortho L M Seed Protectant (Dry)	W	1/2	0.05	

[a] L = Liquid
W = Wettable powder

Table 2. Mean percentages of bunt from seven regional seed treatment tests for the control of SOIL-BORNE common bunt of winter wheat in the Pacific Northwest, 1959.

Treatment	Form[a]	Ounces per bushel	Mean percentage of bunt	Statistical significance
Check - untreated	-	-	68.5	|
Ortho L M Seed Protectant (Concentrate)	L	1/4	56.3	|
Panogen 15	L	3/4	36.5	|
Chemagro D-113	W	2	21.3	|
Panogen E-15019B	L	2	12.1	|
Monsanto Liquid PCNB	L	2	6.3	|
No Bunt 40	W	1	2.2	|
No Bunt 80	W	1/2	2.0	|
Anticarie 80	W	1/2	1.9	|
Stauffer HCB-40	W	1	1.8	|
Smut Go 40	W	1	1.5	|
Anticarie 40	W	1	1.4	|
Sanocide	W	1	0.9	|
Smut Go 80	W	1/2	0.8	|

[a] L = Liquid
W = Wettable powder

Seed of the winter wheat variety Orin, inoculated with bunt spores at the rate of 1/2 gram of spores per 100 ml of seed, was used in all tests with seed-borne inoculum at all locations. Where soil-borne inoculum was used, the spores were sprayed into open furrows at the rate of 1 gram of spores per 10 feet of row.

The seed was treated in units of 250 ml by the method described in a previous report[4]. Treated seed was planted in randomized 10-foot rows with three replications of each treatment at each location. The effectiveness of the different treatments was measured by the percentage of infected heads, based on the total number of heads per row, in each individual row. Calculations of percentages and statistical analyses of the data were made by the Computing Center of Washington State University.

Statistical significance at the 5 percent level, determined by the Duncan method of least significant ranges[5], is indicated in the columns titled "Statistical significance" in Tables 1, 2, and 3. Treatments within the limits of an individual line do not differ significantly from each other, but treatments outside the limits of that line differ significantly from the treatment enclosed by it.

[4]Purdy, L. H. 1955. Regional seed treatment tests for the control of seed-borne and soil-borne common smut of winter wheat in the Pacific Northwest. Plant Disease Reptr. 39: 844-849.
[5]Duncan, D. B. 1953. Multiple range and multiple F tests. Virginia Agr. Exp. Sta. Tech. Report 6a.

Table 3. Mean percentages of bunt from seven regional seed treatment tests for the simultaneous control of SEED-BORNE and SOIL-BORNE common bunt of winter wheat in the Pacific Northwest, 1959.

Treatment	Form[a]	Ounces per bushel	Mean percentage of bunt	Statistical significance
Check - untreated	-	-	79.6	
Panogen 15	L	3/4	47.8	
Ortho L M Seed Protectant (Concentrate)	L	1/4	43.5	
Chemagro D-113	W	2	18.8	
Panogen E-15019B	L	2	13.1	
Stauffer HCB-40	W	1	6.0	
Sanocide	W	1	4.5	
Monsanto Liquid PCNB	L	2	4.1	
Smut Go 80	W	1/2	3.8	
Anticarie 80	W	1/2	3.3	
Smut Go 40	W	1	2.5	
No Bunt 80	W	1/2	2.4	
No Bunt 40	W	1	2.2	
Anticarie 40	W	1	1.5	

[a] L = Liquid
W = Wettable powder

RESULTS

Significant results were obtained from seven of the eight nurseries. The data from these locations were similar, and for this reason the analyses are reported on the basis of the averages from all locations. Summaries of results for the control of seed-borne, soil-borne and seed-borne plus soil-borne bunt, are presented in Tables 1, 2, and 3, respectively.

High percentages of bunt developed in the untreated check rows of all plots. In the tests for the control of bunt developing from seed-borne spores, 77.6 percent bunt developed in the untreated rows (Table 1). Good control was provided by all treatments except Panogen E-15019B, which gave only fair control.

The results for the control of soil-borne bunt are presented in Table 2. High percentages of bunt developed in all check rows of this test and averaged 68.5 percent for all locations. Good control was obtained only with formulations of hexachlorobenzene (HCB), while the formulations of pentachloronitrobenzene (PCNB), Monsanto Liquid PCNB and Panogen E-15019B gave fair control. Chemagro D-113 also gave only fair control, whereas the mercurials Panogen 15 and Ortho L M Seed Protectant (Concentrate) provided poor control.

Results from the tests for the simultaneous control of seed-borne and soil-borne bunt are summarized in Table 3. The incidence of bunt in the untreated check rows averaged 79.6 percent for all locations. In these tests good control was obtained with all formulations of HCB and Monsanto Liquid PCNB. Fair control was provided by Panogen E-15019B and Chemagro D-113, while Ortho L M Seed Protectant (Concentrate) and Panogen 15 were relatively ineffective. The percentages of bunt that developed after mercury treatment reflects good control of the seed-borne phase and illustrates the ineffectiveness of mercurials against the soil-borne phase.

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WATER CORE IN LADY VARIETY APPLES DURING STORAGE

M. J. Ceponis and B. A. Friedman[1]

In the fall of 1958 a large shipment of Missouri-grown Lady apples having a high percentage of visible water core was received on the New York market. Wholesale receivers were concerned about the conditions of the fruit, which is used primarily for its decorative value in the composition of fruit and steamer baskets. Brooks and Fisher[2] reported good recovery in such firm western-grown varieties as Winesap and Arkansas while water core persisted in the softer varieties such as Delicious, Stayman Winesap, and Rome Beauty, making them more susceptible to internal breakdown. Rose et al.[3] advised the quick disposal of soft textured varieties such as Jonathan and Delicious if large portions of the fruit were affected with water core. A storage study was undertaken because there appeared to be no published information on the effects of water core upon the keeping quality of this comparatively firm variety, the Lady apple.

Table 1. Water core, internal breakdown, and decay of stored, Missouri-grown Lady variety apples on the New York market, 1958-59.

Storage period	Number of apples examined	Percent internal water core in apples: Over 2 1/4 inches	2 - 2 1/4 inches	Less than 2 inches	Percent internal breakdown	Percent decay
Arrival (no storage)	541	35.3	28.7	21.3	0	0.7[a]
7 days at 70° F	515	18.5	21.5	11.5	0	3.5
3 months at 35°	472	10.7	10.6	3.2	0	4.0
Plus 7 days at 70°	519	9.8	7.2	6.1	1.8	4.2
5 months at 35°	489	7.8	8.4	2.3	1.0	2.0
Plus 7 days at 70°	508	4.3	4.3	3.8	7.2	7.1

[a] Decayed fruit culled from all apples on arrival. Subsequent decay figures are based on number of apples examined at each storage period. Decayed apples were not cut for internal defects.

Table 2. Internal breakdown and decay of stored, unaffected and water core-affected, Missouri-grown Lady variety apples[a] on the New York market, 1959.

Storage period	Visible water core at arrival: Number of apples examined	Percent: Internal water core	Internal breakdown	Decay[b]	No visible water core at arrival: Number of apples examined	Percent: Internal water core	Internal breakdown	Decay[b]
3 months at 35° F	104	39.6	0.0	7.7	272	0	0	3.7
Plus 7 days at 70°	123	27.6	6.0	5.7	290	0	0	2.4
5 months at 35°	126	26.0	3.3	2.4	273	0	0.4	1.8
Plus 7 days at 70°	108	15.5	18.4	4.6	286	0	3.8	7.3
Total	461			5.0	1121			3.8

[a] 2 inches and over in diameter.
[b] Decayed fruit were not cut for internal defects.

[1] Associate Plant Pathologist and Senior Plant Pathologist, respectively.
[2] Brooks, C., and D. F. Fisher. 1926. Water-core of apples. J. Agr. Research 32: 223-260.
[3] Rose, D. H., L. P. McColloch, and D. F. Fisher. 1951. Market diseases of fruits and vegetables: apples, pears and quinces. U. S. Dept. of Agr. Misc. Pub. 168, 72 pp.

Thirty 1/4-bushel cartons of Lady apples were purchased from the affected shipment. The decayed fruit were removed and the apples sized into three groups. Half of a randomized sample was examined at arrival and the other half after a subsequent 7-day holding period at 70° F. The remainder was stored at 35° with a further separation made of apples 2 inches and over in diameter showing visible water core. Representative samples were withdrawn for examination after 3 months and after 5 months of cold storage.

The percentages of internal water core, internal breakdown and decay found at each examination are shown in Table 1. There was a progressive reduction of water core during cold storage and during the holding period at 70° F. Internal breakdown developed, however, upon holding after 3 months at 35° and became more prevalent during holding after 5 months' storage. The smallest-sized apples had the least amount of water core at each examination.

Internal breakdown was more severe in those apples (2 inches and over in diameter) that had shown visible water core at arrival (Table 2). No internal breakdown was found in unaffected apples until the 5-month storage inspection. After holding for 1 week at 70° F, the incidence of internal breakdown in these apples was about one-fifth of that found in pre-selected water-cored apples. During storage and holding, 5.0 percent decay developed in water-core affected apples, while unaffected apples developed 3.8 percent decay (Table 2). The principal decays were black rot, Alternaria rot, blue mold rot, and gray mold rot. The latter was practically the sole decay observed at the termination of the storage study.

MARKET PATHOLOGY LABORATORY, BIOLOGICAL SCIENCES BRANCH, AGRICULTURAL MARKETING SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, NEW YORK, N. Y.

INCUBATION OF SOIL AND ROOT SAMPLES IN POLYETHYLENE PLASTIC FOR IMPROVED RECOVERY OF NEMATODES[1]

A. C. Tarjan

Summary

Investigations were conducted on the efficacy of 1-mil-thick polyethylene plastic bags as incubation chambers for obtaining maximal numbers of burrowing nematodes from infested soil and root samples. Four tests were conducted determining the effect of length of incubation and temperature on nematode yield. It was concluded that: 1) storage of nematized root and soil samples in sealed polyethylene plastic bags for 6 to 7 days at a temperature of 75° F can result in a substantial increase in yield of burrowing nematodes as compared with yields from non-incubated samples, and 2) just as many or more burrowing nematodes can be obtained from the soil surrounding roots as from the roots.

The experimental phytonematologist often is confronted with the necessity of obtaining the maximum number of nematodes from a given sample. Estimating the number of nemas required, he proceeds to use the one method of retrieving nematodes from soil that he feels is best adapted to his available equipment, energy, and time. If he is fortunate, his requirements are fulfilled in a minimum of time and labor---if the yield is not of ample proportions, he must repeat the process, often several times, until either his goal is attained or his patience is exhausted. In the latter case, the contemplated experiment is usually remodeled in order to utilize the insufficient number of animals obtained. Assuming that an adequate supply of nematodes originally was present in the samples, the final yield could have been enhanced by the utilization of any practice that encouraged evacuation of animals from the material. Further confirmation of the need for obtaining improved yields from samples is illustrated by the current practice in Florida of delimiting margins of burrowing nematode infestation by the presence or absence of Radopholus similis (Cobb) Thorne in soil and root samples from suspect citrus trees. Thus the desirability of striving for maximum yield of nematodes in a given sample is indicated. This report deals with one practice that has given encouraging results.

In the quest for information concerning the longevity of the burrowing nematode of citrus in host-free soil, nematodes were confined by sealing infested root and soil samples in polyethylene plastic bags of 1-mil thickness prior to replacement in the soil. It was found that, under these conditions of confinement, certain nematode species could exist satisfactorily[2], and even thrive for 6 months. The bags in such cases were either buried at various depths in the field, confined in cans of soil in the greenhouse, or merely exposed to prevailing laboratory temperatures. The results obtained instigated certain queries, foremost among which concerned the effect of plastic bag incubation on nematode yield as compared with yield from newly-obtained, non-incubated samples. Thus ensued an investigation of polyethylene bags as incubation chambers for obtaining increased numbers of nematodes from samples.

PROCEDURES

Burrowing-nematode infected citrus feeder roots and infested sub-soil were obtained from a 3-foot depth. Feeder roots were separated, shredded to 1/2-inch lengths, and thoroughly mixed with the accompanying soil. In each of the four experiments performed 250 cc of this soil-root mixture was sealed in 1-mil thick polyethylene "poultry" or "prepackaging" bags of 2-quart capacity.

Samples were divided into four groups, one of which was immediately processed for nematodes. The second group was held at a constant temperature of 75 $\pm$ 2° F in a closed chamber (hereafter referred to as "chamber" samples). The third group was placed in a refrigerator at 30° to 40° (hereafter referred to as "refrigerator" samples), and the fourth was held at laboratory temperatures that fluctuated from 49° to 83°, with the average temperature being 74° (hereafter referred to as "laboratory" samples). Five replicate samples were harvested from each

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[1]Florida Agricultural Experiment Station Journal Series, No. 1023.

[2]Mr. Fred Bisline, Minute Maid Corporation, Plymouth, Florida has reported similar findings (personal communication).

of the three temperature ranges either every 7 days for a total of 21 days (hereafter referred to as Test 1), every 2 weeks for a total of 6 weeks (hereafter referred to as Test 2), or every 3 days for a total of 21 days (hereafter referred to as Test 3). A fourth test was performed in which eight replicate samples were either initially processed for nematodes or were incubated for 6 days at either 70°, 75°, 80°, or 90°.

Following the experimental treatments, feeder root pieces were separated from soil and placed in Baermann funnels for 3 days, after which the liquid contents from each funnel were passed through No. 41 Whatman filter paper in Buchner funnels. Extracted burrowing nematodes were washed from the filter paper into a counting chamber. Nematodes present in soil from each bag were extricated by use of the elutriation device designed by Tarjan, Simanton, and Russell (2). Debris deposited on the collecting screens of this elutriator was placed in Baermann funnels. The following morning burrowing nematodes evacuating the debris were collected and counted as described previously.

RESULTS

TEST 1: In this experiment samples were obtained weekly for a period of 3 weeks. Incubation for a week resulted in the highest average burrowing nematode count from soil in samples stored in the 75° F chamber. However, such was not the case with refrigerator or laboratory soil samples from which nematode counts were not as large as found in samples prior to incubation. There was an increased yield of nematodes from roots that was significant for chamber-incubated samples but of lesser magnitude for samples incubated in the laboratory. A marked increase in nematode yield was obtained from refrigerator root samples after 2 weeks' incubation -- a performance that was repeated in subsequent experiments. Average nematode counts from five replicate root and soil samples for each treatment per sampling date were totaled and are expressed graphically in Figure 1, A. Here it is shown that 1 week's incubation in the 75° chamber increased the burrowing nematode count substantially above the average of 18.6 nematodes found in non-incubated samples processed at the beginning of the test.

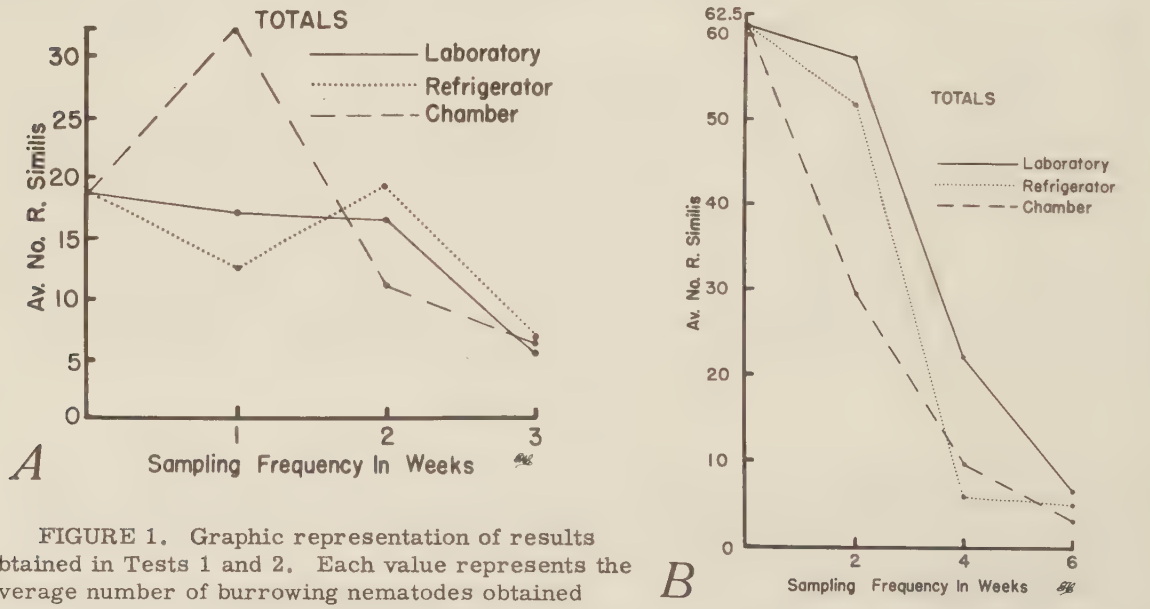
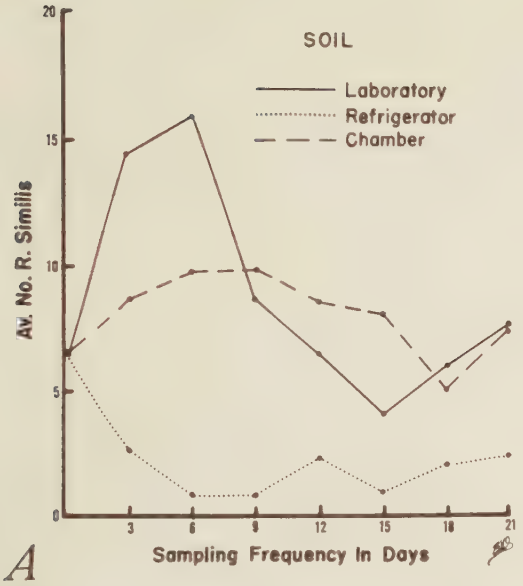
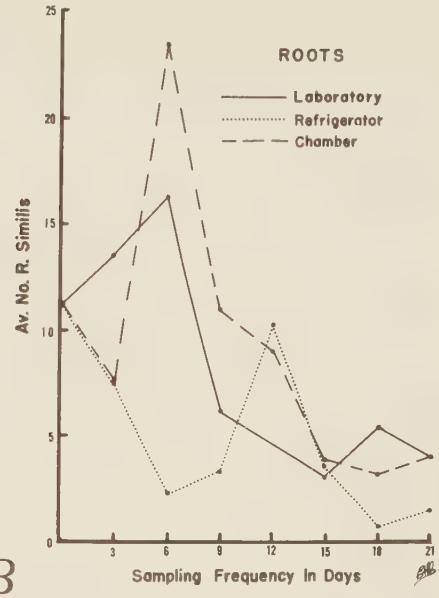


FIGURE 1. Graphic representation of results obtained in Tests 1 and 2. Each value represents the average number of burrowing nematodes obtained from roots and soil of five replicate samples. The starting point on the ordinate for each curve indicates the average yield from non-incubated samples, obtained at the start of the experiment. "Laboratory" refers to samples incubated at laboratory temperatures that fluctuated from 59° to 83° F., with the average temperature being 74°; "refrigerator" indicates those samples stored in a refrigerator held at 35° to 40°; "chamber" designates those samples stored in a constant temperature of 75° ± 2° F.

A -- Results of Test 1 for which sampling frequency was at intervals of 1 week for a maximum of 3 weeks.

B -- Results of Test 2 for which sampling frequency was at intervals of 2 weeks for a total of 6 weeks.





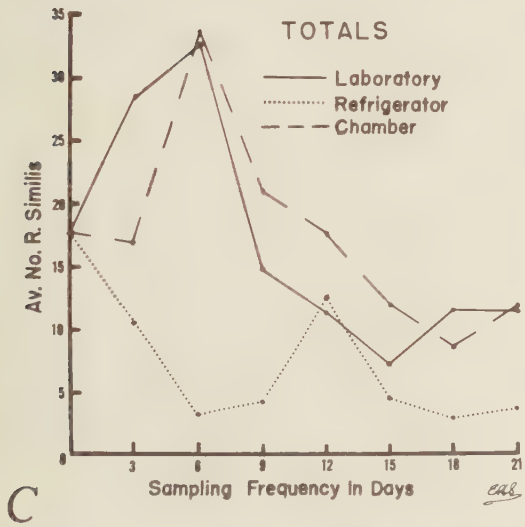


FIGURE 2, A-C. Graphic illustration of results from Test 3 in which sampling frequency was every 3 days for a period of 21 days. Explanations of the curves are the same as appear in the legend for Figure 1.

TEST 2: Harvesting of samples every 2 weeks for a total of 6 weeks gave perplexing results. Average numbers of burrowing nematodes obtained from soil were substantially increased in laboratory samples after 2 weeks' incubation but, in contrast to results of the first test, not in chamber samples. An increased number of burrowing nematodes from roots was obtained only in refrigerator samples after 2 weeks' incubation, confirming results of the first test. When totals were averaged, however, there was no increase in number of nematodes in comparison with the original average count of 61.6 nemas per non-incubated sample (Fig. 1, B).

TEST 3: This was an attempt to determine the cause of the discrepancy between the first two tests by employing a sampling interval of 3 days for a total of 21 days. There was a two-fold increase in average number of nematodes obtained from soil after 6 days' incubation at laboratory temperatures as compared with the number of nematodes initially obtained. Chamber incubation of samples also resulted in increased counts of nematodes from soil, but to not as great an extent as for laboratory-incubated samples (Fig. 2, A). Burrowing nematodes evacuating roots showed the same trends, but in reverse order. After 6 days, chamber samples yielded a two-fold increase in numbers of nematodes, as compared with counts initially obtained, whereas the increase in yield from laboratory samples was less pronounced (Fig. 2, B). As in previous tests, there was a sharp increase in numbers of nemas evacuating refrigerator root

samples after approximately 14 days' incubation. Curves plotted from total numbers of nematodes from samples, combining data from soil and roots, indicate that both laboratory and chamber incubation served equally well for obtaining an increased yield in nematodes, which, in this test, occurred after 6 days' incubation (Fig. 2, C).

TEST 4: Since it was found that the most suitable incubation period for obtaining nemas is approximately 6 days, the purpose of the fourth test was to determine the most effective incubation temperature among the four investigated, namely 70°, 75°, 80°, and 90° F (Fig. 3). Incubation of samples for 6 days, irrespective of temperature, resulted in an increased yield of

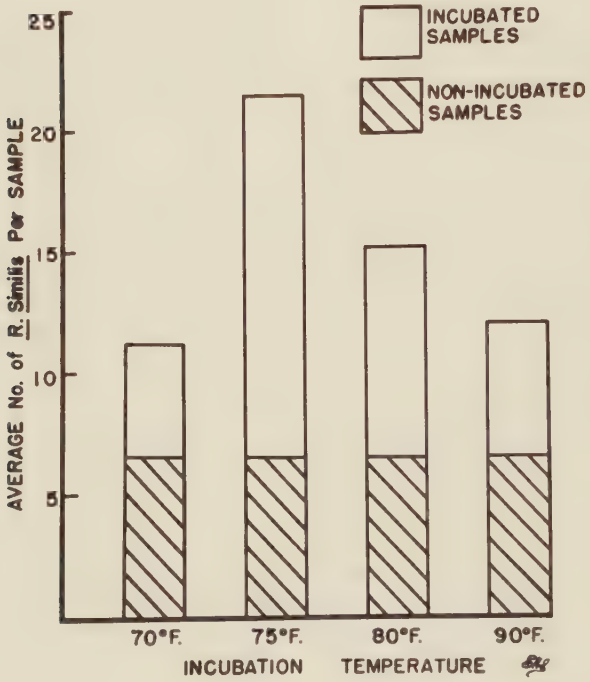


FIGURE 3. Effect of various temperatures on yield of burrowing nematodes from root and soil samples incubated for 6 days. Each value represents the average number of nematodes obtained from eight replicate samples. Average nematode yield from non-incubated samples, obtained at the start of the experiment, is represented by the cross-hatched portion within each bar.

burrowing nematodes as compared with the average number of 6.6 nemas obtained from non-incubated samples at the start of this experiment. The incubation temperature of 75° was clearly the most effective, resulting in more than a three-fold increase in nematodes, as compared with other treatments, whereas the 80° temperature resulted in more than a two-fold increase in nematodes.

DISCUSSION OF RESULTS

The first three tests essentially compared a constant 75° F temperature (chamber), a fluctuating temperature that averaged 74° (laboratory), and a lower storage temperature of 35° to 40° (refrigerator). Hence it is understandable why neither of the first two treatments (conducted at similar average temperatures) was consistently better than the other, despite their superiority over the refrigerator treatment. This is illustrated in Test 1 (Fig. 1, A) where the chamber treatment excelled, yet the reverse situation occurred in Test 2 (Fig. 1, B). Test 3 might have resolved the issue except that Figure 2, A shows laboratory incubation to be the best while Figure 2, B shows chamber incubation to be the best. The combined totals (Fig. 2, C) show both treatments to be of relative equal effectiveness.

Test 1 indicated that maximum count of nematodes was obtained after 1 week's incubation at 75° F., while the number of nematodes obtained at the end of the second week was greatly reduced (Fig. 1, A). Thus the previously enigmatic results of Test 2 (Fig. 1, B), where counts after incubation were lower than the initial counts, are clarified. In this case, the maximum number of nematodes apparently had been present at the end of 1 week's incubation, but, as in the first test, the number dwindled by the end of the second week, at which time the first counting was made. This thesis is confirmed by the results of the third test (Fig. 2, C).

Incubation at several temperatures in Test 4 proved 75° F the most desirable and 80° the next most effective. These facts parallel the views of DuCharme and Suit (1), who reported 75° to 78° to be about optimum for burrowing nematode activity.

Among the side results obtained from these trials was the fact that neither the roots nor the soil consistently yielded more burrowing nematodes than the other. In Test 1 the most burrowing nematodes at each sampling were obtained from the roots, while in Test 2 the reverse situation occurred. In Test 3 the most nematodes were obtained from roots for the first 13 days, after which most nematodes came from soil.

Comparison of counts of females versus males for the tests performed showed that many more females than males evacuated the samples. Although the former were more numerous initially, this relationship rapidly became less apparent, until just a few more females than males were being retrieved at the termination of each test. Male populations seemed more stable numerically, with counts of males decreasing very little during the sampling period.

Although the introduction to this paper stressed the importance of retrieving the largest number of nematodes from samples, such was not possible in these tests because of the number of nematodes lost in passage through the retaining sieves during the washing process. Then too, nematodes undoubtedly failed to leave the debris, pass through the retaining filters, and collect in the stems of the Baermann funnels in the relatively short time alloted for this procedure.

In attempting to deduce why such sudden increases in nematode population were obtained after 6 to 7 days of incubation in contrast to the nematode population in recently obtained, non-incubated samples, one might well consider the possible reactions of nematodes themselves to the altered situation. When roots are excised suddenly from a tree and subjected to an unnatural environment (such as the humid atmosphere of an incubation jar or the watery recluse of a Baermann funnel), it is to be expected that the animals contained within would react atypically to these alien influences. Those nemas that are capable of and inclined toward motility may evacuate their now-undesirable domiciles. Nematode eggs and newly-hatched larvae, suddenly exposed to unfavorable conditions, may fail to develop further and perish. When, on the other hand, excised roots are mixed with soil and sealed in plastic (which retains proper moisture levels, delays dissipation of soil gases, and yet admits oxygen) and incubated at temperatures approximating those found in the rhizosphere, conditions appear suitable for further hatching of eggs, development of larvae, and possibly for continued ovipositon. Excision of roots undoubtedly results in an alteration of available food to nematodes and thus may hasten their development. Despite the reasons motivating the observed population increase phenomenon, nematodes continually were obtained from roots as well as soil throughout the duration of these tests. Hence, one cannot utilize one of these sources to the exclusion of the other if a reasonably valid estimation of total nematode count within the sample is desired.

The interesting and spectacular sharp decline of burrowing nematode populations after 1 week's incubation in sealed polyethylene plastic bags is also open to speculation. Possibly the action of predators is manifested. Then too, the lack of suitable food may be the cause. Regardless of the reason, the necessity of processing burrowing nematode samples after 6 or 7 days' incubation is strongly indicated. Whereas the current tests have reported only the behavior of R. similis under the conditions described, Mr. Simon Malo of this laboratory has obtained similar results from samples containing mixed populations of nematode species (personal communication).

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SOUTHERN CONE RUST: DISTRIBUTION AND CONTROL

Otis C. Maloy[1] and Frederick R. Matthews[2]

Summary

A disease survey revealed that in the area of commercial slash pine production cone rust was heaviest in central and western north Florida. The results of a cone rust survey and studies of methods to control cone rust are presented and discussed. The correlation of cone rust severity with the presence of live oak is emphasized, and it is suggested that seed orchards be established outside of the range of live oak. Ferbam reduced the amount of infection when applied to strobili prior to the stage at which pollination is completed. The results obtained indicate that spray applications give more effective control when made on the basis of weather conditions rather than on flower development alone.

Cone rust, caused by Cronartium strobilinum (Arth.) Hedgc. & Hahn, causes swelling, internal destruction, and premature dropping of cones of slash pine (Pinus elliottii var. elliottii) and longleaf pine (P. palustris). It was first reported in Florida in 1892 (1). The rising demand for slash pine seed has increased the importance of cone rust as a seed-production problem (2). Destructive insects, especially Dioryctria spp., are attracted to diseased cones, and additional losses occur when these insects invade adjacent healthy cones (6).

The uredial and telial stages of C. strobilinum are produced on several species of the evergreen oaks. The telia mature from December through February, producing sporidia which may infect the pine strobili as they emerge from the buds. The developing conelets hypertrophy and ultimately reach sizes many times those of healthy first-year cones. In April and May aeciospores are produced, giving the infected cones a bright yellow color which renders them very conspicuous.

DISTRIBUTION

In 1957 and 1958 surveys were conducted to determine the approximate distribution and severity of cone rust in north Florida and south Georgia[3]. These surveys consisted of rust estimates made at 10-mile intervals along major highways. In May 1959, a more systematic survey was conducted to determine the distribution and severity of cone rust throughout the slash pine range of south Georgia and north Florida. An effort was made to determine whether severity of the disease was related to site conditions or associated with the presence of certain oak species. The survey area was divided into sections 20 miles square. A smaller sample area, 10 miles square, was plotted in the center of each large square. These sample areas were visited, and in most cases both a dry site and a wet site at least 1 mile apart were examined. The percentage of cones rusted on three trees at each site was estimated with the aid of binoculars. The area within a 100-foot radius around the sample trees was examined and the oak species present were recorded.

In all, 184 observations (99 in wet sites, 85 in dry sites) were made in 108 sample areas. The rust was much less severe in Georgia than in Florida, with average rust incidences of 7 and 32 percent respectively. The heaviest occurrence of cone rust was concentrated in central and western portions of north Florida and extended for a short distance into Georgia (Fig. 1). The difference in incidence of rust between wet and dry sites was very small.

Live oak (Quercus virginiana) appears to be the most important alternate host; it was present in 77 percent of the sample locations where rust infection was heavy (more than 30 percent of observed cones rusted). The runner, or ground oaks (Q. minima and Q. pumila), were not observed so frequently in the vicinity of heavily rusted trees. The abrupt drop in incidence of rust in south Georgia coincides very closely with the northern limits of live oak shown by Munns (8). These facts indicate that live oaks in the vicinity of seed orchards and seed-production

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[2] Plant Pathologist, Southeastern Forest Experiment Station.

[3] Roth, Elmer R. 1958 Survey for cone rust (Cronartium strobilinum). Unpublished report, Southeastern Forest Experiment Station. June 19, 1958.

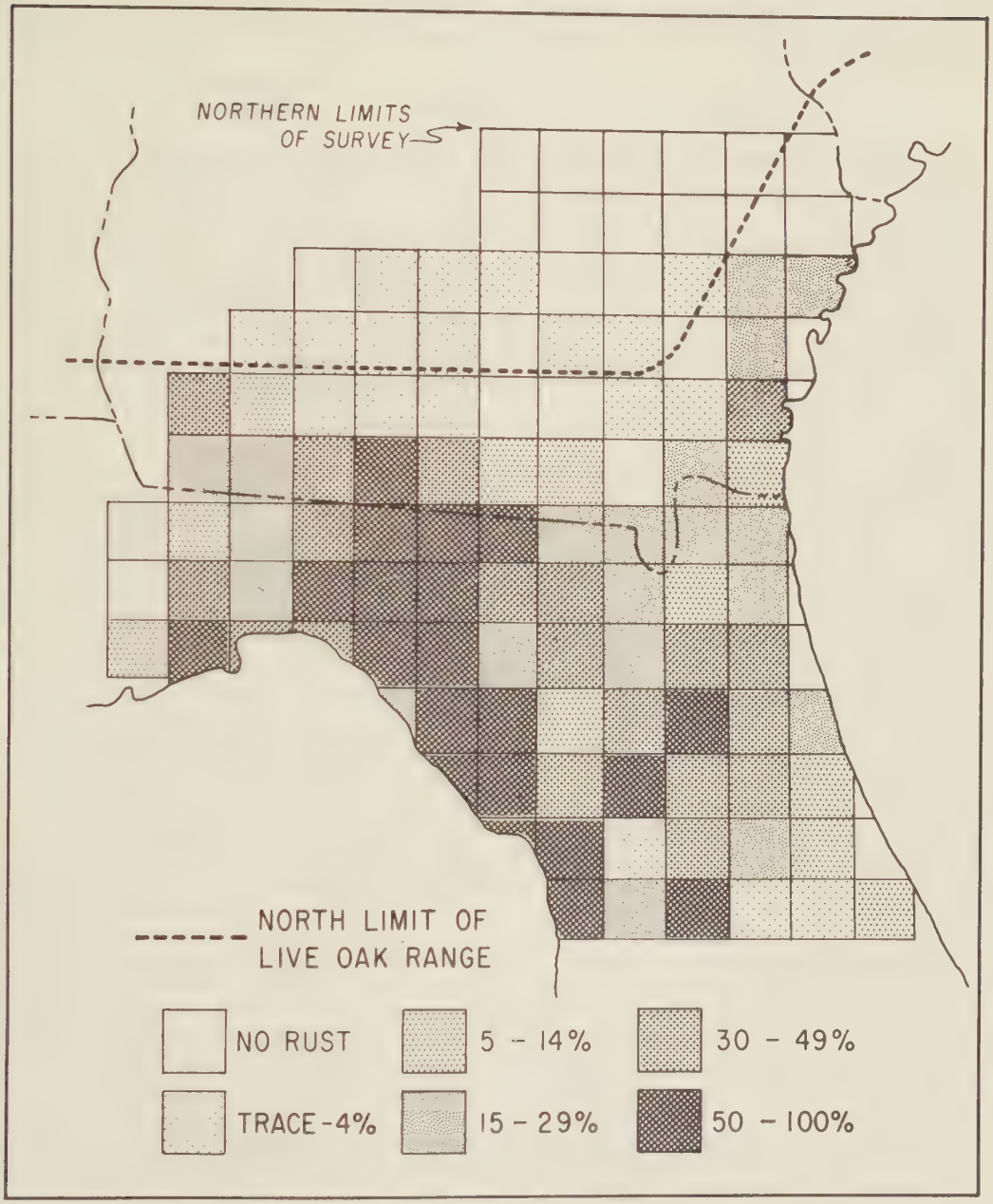

FIGURE 1. Distribution and intensity of cone rust in north Florida and south Georgia in 1959.

areas are the most important sources of inoculum. Obviously, whenever it is possible, slash pine seed orchards should be established north of the live oak range. For the many seed orchards already established in the range of the live oak, however, rust control methods will often be needed.

CONTROL

Studies to develop control measures for cone rust were begun at both the Lake City Research Center[4] and at the Southern Forest Experiment Station in 1958. Jewell's earlier work (3) suggested that bagging female flowers could provide a means of rust control in genetics studies, and that spraying over a limited period would be worth trying as a control measure. Initial studies at Lake City involved the use of four fungicides -- ferbam, captan, basic copper sulfate, and an organic mercury compound. These chemicals were applied as sprays to pine strobili to evaluate their effectiveness in preventing infection by the rust fungus. Results of these preliminary tests indicated that ferbam gave the best control of the rust and was the least phytotoxic. In pollen germination studies ferbam significantly increased the germination of slash and longleaf pine pollen, whereas the other materials inhibited germination (5). The workers at the Southern Forest Experiment Station also reported that ferbam spray afforded protection (4).

In 1959, tests at Lake City were confined to ferbam and Acti-dione RZ[5]. In February, ferbam at a concentration of 2 pounds per 100 gallons of water, with a sticker-spreader, was applied to slash pine strobili in different stages of development (9). Acti-dione RZ, at concentrations of 1, 5, and 25 ppm, was also tested on developing strobili. Ferbam markedly reduced the amount of infection when applied to strobili before or while they were receptive to pollen, that is, up to and including stage 3. Infection occurred in only 3 percent of strobili sprayed once before or during the receptive stage, in comparison with 17 percent rusted for the unsprayed strobili (Table 1). Acti-dione was phytotoxic when applied directly to strobili at concentrations of 1, 5, and 25 ppm. The strobili were most sensitive to injury in the stages immediately preceding pollination. Acti-dione BR at 150 ppm in an oil solution (7) was sprayed on the basal 4 feet of 20 slash pine trees approximately 1 week before strobili began to emerge from the buds, and on 13 other trees about 3 weeks after pollination had occurred. No evidence was obtained that Acti-dione, as used in these experiments, was effective as a systemic fungicide in preventing or arresting cone rust on slash pine.

The most striking control results were obtained when the spray program was correlated with environmental factors that affected sporidial production on oaks and their germination on pine. A daily record was kept of sporidial production, temperature, and relative humidity through January and February. Some increase in the production of sporidia on oak leaves was related to increases in temperature, but periods of intense sporidial production during the season were clearly associated with periods of rainfall or very high humidity.

In a second small-scale control experiment, ferbam was applied to slash pines with immature strobili immediately after each 18-hour or longer period of over 85 percent relative humidity or rain. Two applications corresponded with the highest peaks of sporidial production. Ferbam was very effective when applied so as to protect the strobili during the two periods of highest infection hazard. Only 5 percent of the cones became rusted on the sprayed trees, as compared with 62 percent on the unsprayed trees. The importance of timing was brought out in a third test, when spraying was delayed until a week after the period of highest sporidial production. In this case, a single application of ferbam was made on slash pine trees at Perry, Florida at a time when the scales of the strobili were just beginning to open prior to receptivity. The amount of rust that developed on sprayed trees (55 percent) was similar to that on unsprayed trees (61 percent).

The evidence obtained in these studies indicates that cone rust can be controlled with ferbam. To be effective, however, spray applications must be timed with weather conditions during the period of susceptibility of the strobili to infection. This period probably ranges from the late twig bud stage through stage 3 (just after receptivity), and possibly through stage 4. It coincides generally with the period of sporidial production. Further studies are planned to determine more exactly the stage at which most infection takes place.

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[4] These studies were conducted by the Lake City, Florida Research Center of the Southeastern Forest Experiment Station, in cooperation with several pulp and paper companies and the Florida Forestry Association.

[5] A product of The Upjohn Company, Kalamazoo, Michigan.

Table 1. Percentage of slash pine cones rusted after strobili in different stages of development had been sprayed once with ferbam.

Strobilus stage when sprayed[a]	Strobili sprayed (number)	Cones rusted	
		number	percent
Twig bud	54	0	0
1	74	1	1
1+	85	4	5
2	68	3	4
2+	90	3	3
3 (receptive)	114	2	2
Total	485	13	3
3+	95	27	28
4	112	28	25
Total	207	55	26
Untreated check[b]	252	44	17

[a]Twig bud is the stage before the strobilus emerges from the bud; at stage 4 the strobilus has become a conelet (9).

[b]Checks were exposed to infection during all stages, and so are listed as a single figure. Checks were on the same trees as the sprayed strobili but were bagged during, and just after, the spraying.

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UNITED STATES DEPARTMENT OF AGRICULTURE

CERCOSPORA TRAVERSIANA AND SOME OTHER PATHOGENS OF FENUGREEK NEW TO NORTH AMERICA[1]

Elmar E. Leppik[2]

Abstract

Cercospora traversiana Sacc. (C. trigonellae Maublanc) causes a destructive but little-known leaf spot of fenugreek, Trigonella foenum-graecum. Native to Near East and India, this fungus recently began to spread westward and reached several countries in eastern Europe and South America. It recently was detected in Ames, Iowa on seed samples imported from Ethiopia and East India. Biology, pathogenicity and geographical distribution of this fungus were studied at the Ames station and are briefly reviewed in this paper. Further pathogens of fenugreek, new to North America, are described.

INTRODUCTION

Serious damage of fenugreek caused by a fungus disease was first observed on August 28, 1957 at NC-7 Regional Plant Introduction Station, Ames, Iowa. Large grayish spots appeared on leaves, stems and pods (Fig. 1), and many plants were killed before the seed ripened.

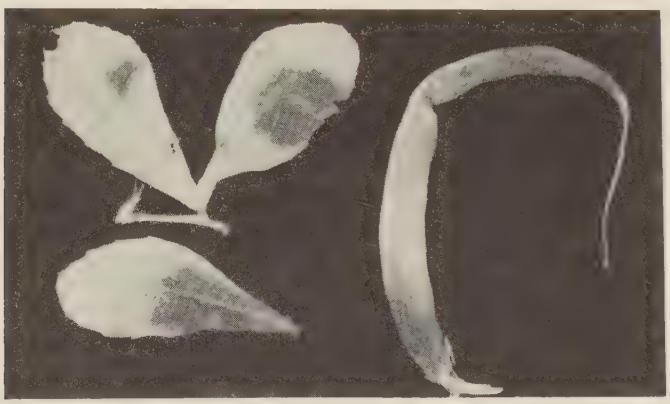

FIGURE 1. Large dark spots caused by Cercospora traversiana on leaves and pods of fenugreek.

The fungus was identified as Cercospora traversiana Sacc. and confirmed by J. A. Stevenson, Principal Mycologist of the National Fungus Collection, Beltsville, Maryland. No previous report on this disease could be found either in United States or Canadian literature. Stevenson (17) lists this fungus among foreign plant diseases.

A study of the Cercospora disease of fenugreek has much interest in itself, but it also demonstrates how seed-borne diseases invade new areas (Fig. 2). Pathological screening of plant introductions at the regional plant introduction stations located at Ames, Iowa, Pullman, Washington, Geneva, New York, and Experiment, Georgia, was started 2 years ago. The increased knowledge of the number and kind of systemic and seed-borne diseases introduced which will be gained from this screening program will make it possible in the near future to determine the extent and seriousness of this problem.

Methods of obtaining disease-free seed from infected seed lots were developed at the Ames station during the past years; thus plant introductions of potential genetic value found to be carrying seed-borne diseases are not necessarily lost. In the present case a program is under way to produce disease-free seed of 14 Cercospora-infected fenugreek introductions discovered during their first pathological screening. A screening of 90 other fenugreek introductions is under way.

Except for the Latin diagnosis of the causal fungus by Saccardo (15) not much is known about the leaf spot of fenugreek. In the present report, therefore, an effort is made to sum-

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[1] Disease Reports of the Regional Plant Introduction Station, Ames, Iowa. No. 1.

[2] Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, Ames, Iowa. The author is indebted to W. H. Skrdla and A. F. Dodge for assistance in facilitating this study.

FIGURE 2. Distribution of Cercospora traversiana (·). Assumed native area of fenugreek is enclosed in circle.

marize some data of observations by the author in Ames Station. Since the question of origin, biology, and distribution of this fungus is closely connected with the distribution and cultivation of its host, a detailed study of fenugreek, as discussed in the next heading, appeared unavoidable.

GEOGRAPHIC DISTRIBUTION, CULTIVATION, AND UTILIZATION OF FENUGREEK

Fenugreek is a rubust annual legume with many economic uses. The plant has been known and grown for medical and religious purposes since remote antiquity and was introduced to various Oriental and Mediterranean countries long before historic time. In India, for instance, fenugreek is mentioned in Sanskrit and in Egypt it was known as one of the oldest cultivated plants (5). It is difficult, therefore, to judge where the plant is truly indigenous and where it is introduced and naturalized, unless consideration is given to the origin and distribution of the Cercospora disease. At present fenugreek is cultivated or found as a weed on cultivated areas in a large territory including Mediterranean countries, southeast Europe, Mesopotamia, Near East, India, Ethiopia, and China. But only in Asia Minor, India, and East Africa is this plant consistently infected by Cercospora. In all western areas of fenugreek the fungus is not known; or it occurs sporadically, introduced by seed from the Orient. This is an obvious indication that fenugreek must have an oriental origin, as mapped in Figure 2.

In India, according to Watt (20, 21), fenugreek grows in the wild in Kashmir, Panjab and the Upper Gangetic Plain and is widely cultivated in many higher regions. It is grown chiefly as a food, fodder, or drug plant, for local use and for export. Sometimes fenugreek is added to fodder to give savour to hay that has become musty.

As human food, fenugreek is largely used as a green vegetable in India and roasted seeds are eaten in Ethiopia (4, 21). For cattle the plant is cultivated in Timbuktu, Morocco, Palestine, and East India (1, 4, 12, 13, 14, 21).

At one time fenugreek was widely cultivated in Europe as a drug plant ("Semina foenigraeci") and was also grown in botanical gardens for demonstration purposes, chiefly for the students of pharmacy. Lately its use in pharmacy has been restricted mainly to the veterinary practice, and its cultivation in Europe has dropped considerably (5, 6, 19, 22).

In the United States fenugreek was imported by early settlers and later reintroduced by the U. S. Department of Agriculture, New Crops Research Branch. In the New World this plant has been used chiefly for green manure and for fodder. At present it attracts the attention of industrialists because of the various oils it contains.

CERCOSPORA DISEASE OF FENUGREEK

Cercospora leaf spot is a rather destructive disease of considerable economic importance. It occurs on leaves, stems, young pods, and seedlings, and damages the plants before ripening.

At Ames, almost 70 percent of the plants grown under moist greenhouse conditions were destroyed. Similar heavy losses are reported from foreign countries where the disease has been observed (7, 13, 18).

Cercospora traversiana is a typical seed-borne fungus, forming systemic mycelium inside the host plant. It begins to develop during germination of the seed and produces conidia abundantly on the seed coat. Conidia grow vigorously in the cold moist atmosphere. Young seedlings of fenugreek may be infected from the conidia produced on the seed coat, but the fungus remains unnoticed in its host for a long time. First symptoms usually appear as large spots on leaves and stems (Fig. 1) during and after anthesis. In this stage of development spread of the disease takes place from plant to plant in the field or in the greenhouse. Soon the young pods are infected and the fungus reaches immature seeds. Infected seeds are not killed immediately but give the fungus shelter for overwintering and for distribution to far distances. The fungus is not easy to detect in seeds and is difficult to control. In spite of quarantine inspection and seed treatment, the disease has gained entry into Estonia, Brazil, and the United States, far from its indigenous area (7, 9).

GEOGRAPHIC DISTRIBUTION OF CERCOSPORA TRAVERSIANA

Cercospora traversiana was first described by Saccardo (15) on fenugreek grown in the Botanical Garden of Padova in June 1903. Maublanc (9) later described this fungus as C. trigonellae, which must be considered as a synonym. Săvulescu and Sandu-Ville (16) described a variety, C. trigonellae caeruleae on Trigonella caerulea, which should be identical with the Cercospora radiata Fuck. f trifolii caerulei Viv. Chupp (3) unites all these species and varieties into a joint taxonomic unit, Cercospora traversiana on Trigonella foenum-graecum and T. caerulea, distributed in Italy, Roumania, Austria, and Brazil. Later Cercospora traversiana was found by Su (18) in Burma, by Leppik (7, 8) in Estonia, by Bremer et al. (2) in Turkey, and by Palti (13) in Israel.

Minz and Solel (10) published a report on a fungus collected on fenugreek from Israel, under the name Cercosporina sp. A sample from this collection, sent by Dr. G. Minz from the Agricultural Research Station in Rehovot, Israel, was found identical with Cercospora traversiana, and is included in the present list.

These limited data on the world distribution of the Cercospora disease on fenugreek can now be augmented by a report of numerous new places of occurrence, as detected from imported seed tested at Ames, Iowa. Infected seed samples have been collected from many localities in Ethiopia, Turkey, Pakistan, Afghanistan, India, Iraq, Iran, Palestine, Jordan and Greece (Fig. 2). So far, 14 fenugreek accessions introduced from the above-mentioned countries have been found infected by Cercospora. No information could be obtained from China. Other species of Trigonella, including T. caerulea, did not show the fungus on seed and remained free from infection. This fact supports the view of Săvulescu and Sandu-Ville (16) that the fungus on T. caerulea might be a different variety, if not a new species, from the one on T. foenum-graecum. Further study may solve this problem.

These data change considerably our understanding of the origin of the Cercospora disease of fenugreek and its geographical distribution. Contrary to the earlier data (3), the main area of distribution of the fungus covers India, Asia Minor, Egypt, and Ethiopia, where the host plant is obviously native (Fig. 2). All European habitats, including the Botanical Garden of Padova, where the Cercospora was first collected from fenugreek and described by Saccardo, are evidently secondary settlements of the fungus introduced by seed. In spite of the very old and extensive culture of fenugreek in all central and western European countries, the leaf spot disease has not yet been observed in these areas. It is also not mentioned in the recent treatise of the drug plant diseases by Mühle (11). Many of the numerous earlier introductions of fenugreek seed have been regrown at Plant Introduction Stations in the United States without any indication of Cercospora disease.

OTHER FUNGI DETECTED ON FENUGREEK

In the United States fenugreek is a new host for several other fungi not yet listed in the Index of Plant Diseases in the United States (23). Many molds and facultative parasites were observed on germinating seed. Some leaf diseases attacked older plants.

Some fenugreek accessions suffered from a physiologic disturbance, the cause of which has not yet been determined. The diseased plants were covered with fine brown spots, which ap-

peared first on leaves, then on stems and finally on pods (Fig. 3). Heavily attacked plants died early and produced very few seed of inferior value. This malady is provisionally called brown stipple of fenugreek.

FIGURE 3. Brown stipple disease on stem, leaf and pods of fenugreek.

The following fungi were observed on fenugreek in Ames during the years 1957-1959: Alternaria tenuis, sensu Neergaard, on seed; Aspergillus sp., on germinating seed: Botrytis cinerea Pers., on leaves and pods; Cladosporium herbarum Link, on seed; Cladosporium cladosporioides (Fres.) De Vries, on seed; Fusarium sp., on germinating seed; Penicillium sp., on germinating seed; Rhizopus nigricans Ehr., on seed coat; Stemphylium botryosum Wallr., on seed.

DISCUSSION

Although fenugreek is a very old cultivated plant in both the Old and New Worlds, the Cercospora disease did not appear in older cultures of this plant. The first discovery of Cercospora traversiana by Saccardo (15) in Italy and later observations made by Săvulescu and Sandu-Ville (16) in Roumania and Austria mislead earlier mycologists, who considered this disease as being of European origin. Newest findings, particularly the analysis of seed samples from various countries of Near East, India, and Ethiopia, enlarge considerably the known area of geographic distribution of this fungus. They also indicate that Cercospora traversiana must be native in Asia Minor and India and only lately introduced into western countries.

From the present analysis of a large number of seed samples from various countries it appears that some new and particularly vital races or strains of Cercospora traversiana have started their spread from the Near East and are now ready to invade the American continent.

Many seed-borne and systemic diseases, including Cercospora traversiana, are difficult to detect in the seed because their symptoms appear first on growing plants.

Quick discovery of the leaf spot fungus on fenugreek at Ames made elimination of infected accessions simple and less expensive than ordinarily would be the case for a large-scale eradication program.

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NORTH CENTRAL COOPERATIVE PLANT INTRODUCTION PROJECT NC-7,
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STATUS OF PERSIMMON WILT, 1959

E. R. Toole and P. C. Lightle

Persimmon wilt, caused by Cephalosporium diospyri Crandall, is a fast-killing vascular wilt of the American persimmon (Diospyros virginiana) first reported from central Tennessee in 1936. This paper summarizes current knowledge on its distribution and the damage it causes.

Crandall and Baker reported persimmon wilt in Tennessee, Mississippi, Alabama, Florida, Georgia, and South Carolina in 1938. A year later it was also found in North Carolina and Texas. Observations in 1948 indicated that the disease was present in all these States except North Carolina[1]. No later reports have been found in the literature.

In June 1959, Mr. Clyde A. Bower, Oklahoma State Entomologist, called our attention to possible persimmon wilt in Oklahoma. Later observations showed that it was abundant in several areas in Pontotoc County, Oklahoma. Many plants were completely defoliated, although some infected ones still retained dwarfed, yellowed leaves (Fig. 1). Cephalosporium diospyri was isolated from discolored wood, and pink conidial spore masses typical of this fungus were found beneath the bark of some wilted trees. This appears to be the first report of the disease in Oklahoma.

FIGURE 1. Persimmon killed by wilt near Fittstown, Oklahoma.

Observations of persimmon in Alabama, Arkansas, Louisiana, Mississippi, and Tennessee by the authors since 1952 have disclosed no evidence of wilt, even in areas where it was formerly common.

Wilt has not been found in timber-producing areas, which are limited largely to the rich bottomlands of the Mississippi River and its tributaries and to the coastal river valleys.

In parts of central Tennessee, where the disease was first reported, wilt has practically eliminated the host as a dominant species. Limited scouting in the vicinity of Lebanon and Nashville in 1958 disclosed only a few scattered small plants and none of the formerly common thickets.

Elsewhere in the South, persimmon remains a common small-tree invader of pastures, fence rows, and abandoned fields. Except for some locations in Tennessee and possibly Oklahoma, wilt does not appear to have affected the prevalence of persimmon. There are rumors that farmers in Oklahoma have spread the wilt organism as a control of persimmon in pasture lands, where it is considered a weed.

SOUTHERN FOREST EXPERIMENT STATION, FOREST SERVICE,
UNITED STATES DEPARTMENT OF AGRICULTURE

[1] Crandall, B. S., and W. L. Baker. 1950. The wilt disease of American persimmon, caused by Cephalosporium diospyri. Phytopathology 40: 307-325.

ROSE MOSAIC CURED BY HEAT TREATMENTS

Francis O. Holmes

Mosaic disease of roses (Rosa spp.), especially when caused by a yellow-mottling strain of rose-mosaic virus (Marmor rosae H.), produces disfiguring malformation and mottling of leaves. Less severe strains of the virus produce milder disease, which may not be recognized readily at some seasons.

Brierley and Smith[1] found that transmission of rose mosaic by insects either did not occur or was very infrequent in the areas that were involved in their study, namely Maryland, New York, Virginia and Oregon. They suggested that the disease probably could be controlled by the use of healthy understocks and virus-free budwood.

For this reason, development of methods by which healthy sources of budwood can be made from clearly affected mosaic stocks of rose varieties would be desirable. Heat treatments seem capable of doing this, as the following results show.

A plant of the rose variety known as Grüss an Teplitz was found affected by a yellow-mottling mosaic that produced considerable leaf malformation[2]. All rooted cuttings of a subclone produced vegetatively from this plant displayed typically mottled foliage (Fig. 1A).

FIGURE 1. Leaves of the Grüss an Teplitz rose. A -- from a mosaic plant. B -- from a plant of the same clone cured by a 6-week heat treatment.

Small mosaic plants of the affected subclone, grown in 4-inch clay pots, were kept in an incubator for periods of 1 to 10 weeks. Light was provided during a period of 16 hours in each day by ten 14-watt white fluorescent-tube lamps above a sheet of glass that formed the top of the incubator, about 1 foot from the tops of the plants. Intensity of the light was about 250 foot-candles near the foliage.

Soil temperatures of the incubated plants were held at 33 1/2° to 34° C for a time and then were increased to about 36°. The actual temperatures and times of exposure are shown in Table 1. These soil temperatures were maintained only about 1/2° to 1 1/2° C below the air tem-

[1]Brierley, Philip, and Floyd F. Smith. 1940. Mosaic and streak diseases of rose. J. Agr. Research 61: 625-660.

[2]Cuttings of this plant were obtained through the kindness of Dr. George S. Avery, Jr., Director of the Brooklyn Botanic Garden, Brooklyn, New York.

Table 1. Details of heat treatments for mosaic plants of the Grüss an Teplitz rose.

Total time in incubator (in weeks)	Number of weeks at soil temperature 33 1/2° to 34° C	Number of weeks at soil temperature 36° C	Result
1	-	1	Not cured
2	-	2	do.
3	3	-	do.
4	1	3	Cured
5	4	1	do.
6	4	2	do.
10	4	6	do.

peratures around the plants by enclosing the clay pots in plastic bags. Small holes were cut in the bottoms of these bags to provide drainage. The plastic reduced evaporation from the outer surfaces of the pots to a minimum. Probably the slightly lower temperatures of the soil were matched by comparable decreases of temperatures in the foliage, because some evaporation from leaves would occur in the incubator and leaf temperatures would thus be slightly lower than air temperatures.

As indicated in Table 1, plants removed from the incubator after periods of 4, 5, 6, and 10 weeks continued for a time to show chlorotic patterns on leaves that had been affected earlier, but new foliage developing on these plants appeared healthy during the entire period of observation, which amounted to more than 40 weeks. On the other hand, plants removed from the incubator and returned to greenhouse conditions after 1, 2, and 3 weeks showed mosaic symptoms both on old and on newly developing leaves throughout the same period of observation, as did all of eight control plants that had not been heated. Figure 1A shows the appearance of an affected leaf from a diseased plant; Figure 1B shows that of a comparable leaf from a plant cured by treatment for a total of 6 weeks, that is, by 4 weeks at 33 1/2° to 34° C and 2 additional weeks at 36° C soil temperature. Presumably the incubator temperatures, though moderate, were high enough to prevent existing virus from replacing itself at a rate commensurate with the prevailing rate of its inactivation.

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THE VECTOR-VIRUS RELATIONSHIP OF THE SWEETPOTATO WHITEFLY AND A MOSAIC OF SWEETPOTATOES IN SOUTH GEORGIA

J. H. Girardeau, Jr., and T. J. Ratcliffe[1]

Summary

It was established that the sweetpotato whitefly, Bemisia tabaci, is the principal vector of a sweetpotato mosaic virus in South Georgia. No other vector was found. The whitefly became infective after 1-day exposure to a virus-infected plant and transmitted the virus after 1-day exposure to a virus-free plant.

Girardeau (3) reported in 1958 that Bemisia inconspicua (Q), the sweetpotato whitefly, was the vector of the mosaic-producing virus reported by Borders and Ratcliffe (1) in 1954. Hildebrand (4) stated that this virus was "feathery mottle" as described by Doolittle and Harter (2) in 1945. There is still some question as to its positive association with the name "feathery mottle" mosaic and, therefore, it is called sweetpotato mosaic by the plant inspection service in Georgia. Russell (5) states that Bemisia inconspicua (Q) is a synonym of Bemisia tabaci (Genn.). She identified the original group of whiteflies in 1956 as Bemisia inconspicua, and the specimens in 1959 as Bemisia tabaci (Genn.), which were colonies maintained from the original collection.

The disease was first noticed in commercial plantings in Georgia in 1945, and in 1946 this planting stock was destroyed. The disease was not observed again until 1952. In 1953, 48 fields were found infected with the virus, and the disease reached its widest spread in 1957.

In the fall of 1952, Borders and Ratcliffe (1) began an investigation of the disease. They established that the virus was apparently insect-borne and also found that the use of a phosphate insecticide retarded or eliminated the spread within a planting and that caged plants did not become infected. This report is a continuation of their work.

EXPERIMENTS AND RESULTS

During the growing season of 1956 the senior author began surveying the insects occurring in the sweetpotato fields of South Georgia where spread of the disease had been noted. The sweetpotato whitefly, B. tabaci, and the sweetpotato leaf hopper, Empoasca fabalis Delong, occurred in very large numbers. Aphids were almost non-existent in the plantings.

Tests were conducted during the 1957 season to determine if B. tabaci was a vector for this virus. In these first tests three 6-inch pots were placed in 32-mesh lumite screened cages, consisting of one virus-infected plant and two virus-free plants. Colonies of insects were started in these cages using field collected material. These colonies were held under screened-in insectary conditions through one generation of the insect. The originally virus-free plants were then sprayed with malathion and held for observation. In six such tests, using B. tabaci, five transmissions were obtained. In all tests using E. fabalis, Myzus persicae (Sulz) (the green peach aphid), or gross sweepings of insects with the whiteflies extracted, no transmission was observed.

In 1958 emphasis was placed on verifying the previous year's observations on B. tabaci. A series of 26 tests using one potted virus plant and four virus-free plants in each 64-mesh screened cage was set up. Forty whitefly adults were placed in each cage and allowed to continue through one generation, after which the original virus-free plants were sprayed and held for observation. Seventeen positive transmissions were obtained in the 26 tests. In these tests records on 85 originally virus-free plants were available with 32 individual plants expressing positive symptoms. The plants unaccounted for died from various causes incident to growing them under confined conditions.

A second series of tests was conducted in which the insects were allowed to remain for varying periods on a virus-infected plant and then moved to virus-free plants for specific peri-

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ods. The whiteflies were reared on virus-free plants and transferred as adults to caged virus-infected plants with an aspirator. Since it was difficult to determine whether an individual insect had fed on a plant, groups of 10 adults were used as a unit for transfer. A large group of virus-free adults were placed in a cage with a potted virus-infected plant, and after a given exposure time they were transferred in units of 10 to caged virus-free plants. After exposure to the virus-free plant for an exposure period of 1 to 5 days the survivors were recovered and placed on additional caged virus-free plants. Table 1 summarizes these tests where one transfer was made. In 61 tests, 27 positive transmissions were secured. The erratic longevity pattern of the test insect made the longer exposure times difficult to accomplish.

Table 1. The transmission of a sweetpotato virus by the adult sweetpotato whitefly.

Days of exposure to virus plant	Days of exposure of viruliferous whiteflies to virus-free plants					
	1	2	3	4	5	Total
1 or 2	7/4[a]	15/6	11/3	3/0	8/4	44/17
3	0/0	0/0	2/0	7/5	1/1	10/6
4	0/0	0/0	4/2	0/0	0/0	4/2
5	0/0	1/1	2/1	0/0	0/0	3/2
Total	7/4	16/7	19/6	10/5	9/5	61/27

[a]First figure denotes number of tests; second figure, number of tests producing a transmission of the virus.

Twenty-three tests were conducted using whiteflies reared on virus plants prior to their transfer to virus-free plants. In these exposures only two positive transmissions were recorded.

In 10 tests utilizing whiteflies which had been exposed to virus-infected plants and then to virus-free plants prior to placing on the final virus-free test plants, no transmissions were evident. Five (or 50 percent) of the original transfers produced a positive virus transmission. In three tests where a positive transmission of the virus was shown in the first transfer, no transmission was evident when the whiteflies were moved to a second and a third virus-free plant.

In all of the 1958 tests the original clones of virus-free plant stock were used as virus-free controls. After the plants were exposed to viruliferous whiteflies they were sprayed periodically in the holding area. Unexposed virus-free plants interspersed throughout the holding area showed no virus infection, which indicated that no accidental spread took place.

In 1959 attention was directed to field conditions and reactions of the plants and the vector. At the time of this writing only one transmission test had been completed. In this test, using insectary-reared whiteflies exposed for 2 days to virus-infected plants, 20 plants in a field planting of virus-free plants were exposed to 10 viruliferous whitefly adults. These field exposures were made on May 14-16. At the time vine cuttings were made on July 7, four of the original field plants showed symptoms of the disease. On August 14, fourteen of the original hills showed virus symptoms under field conditions, and the vine cuttings made from these identical plants showed severe mosaic symptoms. The virus did not appear to restrict root development on the original planted draws which were in full vigor at the time of transmission. The vine cuttings made from the virus-infected draws produced few roots.

CONCLUSIONS

These tests demonstrated that the whitefly, B. tabaci, is an effective vector of the sweetpotato mosaic. It was shown that the whitefly could acquire the virus during a 1-day exposure of the virus source and could transmit the virus after a 1-day feeding period on the virus-free plant. It was also demonstrated that a sweetpotato whitefly does not have to complete a life cycle on the virus source in order to transmit the virus. Indications are that the whitefly loses its ability to infect other plants after it has fed on one virus-free plant.

The normal time elapse between exposure of a virus-free plant to viruliferous whiteflies and expression of readable symptoms is 60 days. The use of large quantities of infected whiteflies did not always speed up the expression of symptoms, although expression was secured on one occasion in 8 days when 200 infected whiteflies were used. In some cases 6 months were required for visible symptomatic expression.

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REACTION OF COWPEAS, VIGNA SINENSIS, TO ROOT-KNOT NEMATODES, MELOIDOGYNE SPP.

Ivan J. Thomason and H. E. McKinney[1]

Summary

Forty-four cowpea (Vigna sinensis) varieties and plant introductions were tested for their reaction to the root-knot nematodes Meloidogyne incognita acrita and M. javanica. All lines tested showed some resistance to M. incognita acrita but were moderately to highly susceptible to M. javanica as indicated by the ability of the nematodes to reproduce on the hosts.

The asparagus bean (Vigna sesquipedalis) was susceptible to M. incognita, M. incognita acrita and M. javanica but resistant to M. hapla.

The root-knot nematodes Meloidogyne javanica (Treub, 1885) Chitwood, 1949, Meloidogyne incognita (Kofoid and White, 1919) Chitwood, 1949 and Meloidogyne incognita acrita Chitwood, 1949 are serious pests of cowpeas, Vigna sinensis var. Blackeye, in California. The varieties commonly grown, Blackeye 5, Chino 3, and Grant, have resistance to M. incognita and M. incognita acrita but are susceptible to M. javanica. M. javanica is the more common species observed on cowpeas in Southern California. Of 22 samples of cowpea roots collected in Orange, Riverside and San Bernardino counties, 18 were infected with M. javanica and 4 with M. incognita acrita. Grant, a Fusarium wilt tolerant variety grown in the Chino Valley of San Bernardino County, is highly susceptible to M. javanica (2).

Tyler (5) in 1941 summarized the reports of root-knot nematode resistance in cowpeas. The results of the tests reported prior to 1941 and until the time that Chitwood (1) described the several species in the genus Meloidogyne are of limited value because the species of root-knot nematode observed or used in the tests is not known.

Recently, Hare (3) reported Iron cowpea and four breeding lines M255, M455, M755, and M855, were resistant to M. javanica, M. incognita, M. incognita acrita and M. arenaria (Neal, 1889) Chitwood, 1949, when tested as young plants in the greenhouse. The varieties Arlington, Groit, Red Chinese, Long Pod Cream, Extra Early Blackeye, Bunch Purple Hull, Mississippi Crowder, Dixilee and Brown Sugar Crowder were reported to be susceptible to all species.

In a search for root-knot nematode resistance in cowpeas, the authors tested a number of varieties and plant introductions for their reaction to M. incognita acrita and M. javanica.

MATERIALS AND METHODS

Greenhouse Tests: Single egg mass populations of the following root-knot nematodes maintained on Rutgers tomato were used for inoculum: M. incognita acrita, population Ia-4-54, from Lippia sp., Indio, Calif., and M. javanica, J-7C-55, from cowpea, Chino, Calif. Five grams of galled tomato roots were used as inoculum in each 6-inch clay pot and the cowpeas seeded[2] directly in the pots. Ten plants of each variety or accession number (five in each of two pots) were tested against each nematode species. In all tests Rutgers tomatoes were included as a check on the inoculum potential.

Six weeks after emergence the roots of the plants were washed free of soil and rated for the severity of root galling and the amount of nematode reproduction. The ability of the nematode to reproduce was emphasized. Roots were examined macroscopically and with the aid of a dissecting microscope. The following rating system was used: 0 -- no infection, or if larvae entered the roots they did not develop into egg laying females; 1 -- very light infection, with only an occasional female egg mass; 2 -- light infection with mature females and egg masses easily seen with the naked eye; 3 -- moderate infection with mature females and egg masses moderately abundant; and 4 -- a severe infection with mature females and egg masses abundant. An average reaction for each variety or number was then calculated.

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[2]Seed for these tests were kindly supplied by Dr. Byron Houston, Department of Plant Pathology, University of California, Davis, California.

Table 1. Reaction of cowpeas, Vigna sinensis, to root-knot nematodes, Meloidogyne spp.

Variety or Plant Introduction no.	Susceptibility ratings: M. incognita acrita	M. javanica
PI 115,637	0.5	--
PI 115,681	0.8	2.0
PI 115,739	1.0	3.5
PI 121,433	0.0	2.5
PI 124,600	1.0	2.0
PI 145,198	0.3	4.0
PI 147,071	0.5	3.6
PI 147,077	0.8	3.0
PI 148,677	0.6	4.0
PI 152,199	0.0	2.3
PI 154,134	1.4	3.0
PI 162,925	0.7	2.3
PI 163,413	0.3	2.0
PI 164,337	0.0	4.0
21 - 2	0.0	2.8
Alacrowder	1.0	4.0
Arlington	1.0	4.0
Blackeye 5	0.2	3.0
Blackeye 7	0.4	2.3
Browneye 7	0.0	3.0
Browneye 8	1.0	3.0
Browneye 9	0.3	2.5
Chinese Red	0.0	4.0
Chino 2	0.0	2.5
Chino 3	1.0	3.7
Early Red	0.5	4.0
Early Sugar Crowder	0.6	3.0
Extra Early Blackeye	1.2	3.0
Grant	1.0	4.0
Groit	0.0	2.5
Honolulu	1.5	3.0
Iron 3-5	0.5	3.3
Iron 9-1	0.0	3.0
Iron 9-10	0.5	3.1
Lady	1.2	4.0
New Era	0.0	3.1
Red Ripper	0.3	3.0
Rice	0.8	3.5
Suwanne	0.0	3.0
Texas Purple Hull	1.0	3.0
Victor	0.5	3.0
Virginia Blackeye	1.0	3.3
Whippoorwill	1.0	3.1
Rutgers tomato Check	3.0	3.5

Table 2. Reaction of cowpea breeding line M755 to Meloidogyne javanica in greenhouse and field tests.

Location	Number of plants in each susceptibility class: 0	1	2	3	4	Total number of plants	Average reaction
Field	3	46	51	38	5	143	2.0
Greenhouse	0	19	22	13	4	58	2.0

Table 3. Reaction of the asparagus bean, Vigna sesquipedalis, to four Meloidogyne spp.

Meloidogyne sp.	Susceptibility rating
M. incognita	4
M. incognita acrita	4
M. javanica	4
M. hapla	1

In a similar test a larger number of plants of the breeding line M755 supplied by Dr. W. W. Hare of Mississippi State University were tested against population J-7C-55 of M. javanica. Twenty-four 6-inch pots containing five plants each were included in the test. Inoculation procedures and scoring were as indicated above.

The susceptibility of the asparagus bean, Vigna sesquipedalis, to M. incognita, M. incognita acrita, M. javanica and M. hapla Chitwood, 1949, was tested using the procedure outlined previously. The reaction of 10 plants to each species was determined. Root-knot nematode populations used in the tests are as follows: M. javanica, mass population J-5-54 from alfalfa, Fresno, Calif.; M. incognita acrita, mass population Ia-15-55 from tomato, Davis, Calif.; M. incognita single egg mass population I-1d-54 from tomato, Seeley, Calif.; and M. hapla, mass

population H-4-55 from tomato, Davis, Calif.

Field Test: A field area moderately infested with M. javanica (population J-7c-55) was used to test progeny of the breeding line M755 further. Ten rows 3 feet apart and 15 feet long were seeded to M755, on June 1. Two seedlings of Rutgers tomato were transplanted into each row at seeding time. Growth of the cowpea plants was observed during the growing season, and on September 18 the plants removed from the soil and the roots scored for nematode galling and reproduction as indicated previously. The Rutgers tomato plants were also removed at this time and the roots scored.

EXPERIMENTAL RESULTS

The cowpeas tested ranged from moderately to highly susceptible to the root-knot nematode M. javanica as indicated by the ability of the nematode to induce gall formation on the roots and to reproduce. These same cowpeas proved to be moderately or highly resistant under the conditions of these tests to the population of M. incognita acrita used (Table 1). Many of the varieties and introductions had vigorous root systems and grew quite well despite the presence of M. javanica. However, the ability of M. javanica to reproduce on these plants indicates that they would not be ideal sources of resistance in a breeding program.

Reproduction of M. javanica, as measured by the presence of egg masses, on plants of breeding line M755 ranged from none to very heavy when tested in the greenhouse and the field (Table 2). The mean susceptibility reaction for this variety under both conditions was a 2 or moderately susceptible. Galling was not severe in most cases but numerous egg masses occurred on some plants. Progeny from plants showing a 0 reaction were not tested to determine whether they were resistant individuals or escapes. This line has a strong, vigorous root system and grew quite well despite the presence of moderate root-knot infection.

The asparagus bean was susceptible to M. incognita, M. incognita acrita and M. javanica (Table 3). It was resistant to M. hapla. Although many of the cowpea varieties and plant introductions tested were highly resistant to M. incognita and M. incognita acrita, none had a high level of resistance to M. javanica as measured by the ability of the nematodes to reproduce on the hosts.

DISCUSSION

Although Hare (3) found Arlington, Groit, Red Chinese, and Extra Early Blackeye susceptible to M. incognita acrita in his tests, these varieties showed considerable resistance in the tests reported here. The difference may be due to the level of the inoculum used (in these tests the susceptible Rutgers tomato check showed only a 3 reaction to M. incognita acrita) and/or to a difference in the virulence of the two populations. Minz (4) reported asparagus bean as a host of M. javanica in Israel, which agrees with our results.

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DIFFERENCES IN PATHOGENICITY AND PYCNIDIAL PRODUCTION AMONG ISOLATES OF PYRENOCHAETA TERRESTRIS FROM A SINGLE PINK ROOT INFESTED FIELD IN LOUISIANA[1]

M. M. Kulik and E. C. Tims[2]

Summary

The pathogenicity of 91 mycelial isolates of Pyrenochaeta terrestris from a single pink root infested field was determined by greenhouse tests. The isolates varied a great deal in their ability to attack onion roots. They could be fairly evenly separated into each of the four disease categories used to record the disease development on the roots of the onion seedlings grown in pots of infested sand.

The same isolates that were used in the pathogenicity tests were grown on bean-pod agar slants for 57 days at 27° C. At the end of this time eight of them had produced pycnidia. Ten other isolates had produced pycnidium-like bodies characterized by the absence of spores and setae. The mean disease index rating for the 18 isolates which had produced pycnidia or pycnidium-like bodies was 73.5. This figure is much higher than that for the 91 isolates taken as a whole, namely 53.1, and also greater than 48.1, the mean for the 73 isolates that did not produce pycnidia or pycnidium-like bodies.

INTRODUCTION

Gorenz, Larson, and Walker (5) found in their investigation of pink root that isolates of Pyrenochaeta terrestris from 14 locations in 10 States varied widely in virulence. The results of some of their tests not presented in detail indicated that this variation in virulence existed among isolates from the same locality. The present study was conducted to determine the amount of variation in pathogenicity that might be found among isolates of the pink root fungus from a single infested field.

Carvajal (1) observed that pycnidia were readily formed by all the isolates of Pyrenochaeta terrestris that he used when they were grown on potato-dextrose agar at room temperature in subdued, natural light. Hansen (6) had reported that although the formation of pycnidia was good on corn meal agar, very few pycnidia formed when isolates were grown on Czapek's, Conn's, Board of Health, Pfeffer's, and other synthetic media. Frierson (3) reported that some of his isolates of the pink root fungus produced pycnidia when grown on corn meal or bean agar. In others the production of pycnidia was never observed.

MATERIALS AND METHODS

Ninety-one mycelial isolates of Pyrenochaeta terrestris were obtained by plating infested roots from onion seedlings grown in naturally infested soil. The soil was a composite sample taken from a single field on a shallot farm in Chack Bay, Louisiana. Shallots had been grown in this field for many years and the area from which the soil sample was taken was known to be heavily infested with the pink root fungus. The cultures were kept on slants of modified Czapek's agar at 7° C.

The inoculum was prepared as follows: transfers were made from the stock cultures of P. terrestris to Petri dishes containing modified Czapek's agar and kept at 27° C for 10 days. Four 1-cm squares from the border of the fungus mats in the Petri dishes were transferred to 200 ml of modified Czapek's medium[3] in 500-ml flasks, which were kept on a laboratory table at room temperature for 12 days with daily shaking the first 8 days to insure adequate aeration. The fungus and medium were macerated in a Waring Blendor for 1 minute, and

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[1] Portion of a dissertation submitted by the senior author to the Graduate School of Louisiana State University in partial fulfillment of the requirements for the Ph. D. degree in Plant Pathology.

[2] Respectively, First Lieutenant, U. S. Army Biological Warfare Laboratories, Fort Detrick, Maryland, formerly Graduate Research Assistant; and Professor of Plant Pathology, Louisiana State University, Baton Rouge, Louisiana.

[3] Formula for modified Czapek's medium used by Gorenz, Larson, and Walker (5): 2g $NaNO_3$, 1 g KH_2PO_4, 0.5 g KCl, 0.05 g $MgSO_4$, 0.01 g $FeSO_4$, 50 g dextrose, 15 g malt extract, 1000 cc water.

200 ml of this inoculum was diluted with 500 ml of Hoagland's solution[4] and mixed with 10 kg of sand.

Four 4-inch pots were filled with sand inoculated with each of the 91 isolates. The pots were placed on a greenhouse bench in an 80° F greenhouse, and 50 seeds of the pink root susceptible onion variety White Sweet Spanish were sown in each pot. The seeds were covered with clean sand to a depth of about 1/2 inch, moistened with a fine spray, and the pots were covered with newspaper until the seedlings emerged. Cardboard partitions were used to separate the pots in the different lots to prevent the mixing of inoculum from adjacent pots. The pots were watered daily, and once each week they were watered with Hoagland's solution.

The seedlings were carefully removed from the pots 49 days after planting and were then counted and weighed. The plants were divided into five disease classes, a system used by Gorenz, Larson, and Walker (5), in which each was given a class weight as follows: no pink root, 0; 1 to 25 percent of roots infected, 25; 26 to 50 percent infected roots, 50; 51 to 75 percent infected roots, 75; 75 to 100 percent infected roots, 100 (Fig. 1).

FIGURE 1. Onion seedlings divided into five disease categories.

A disease rating for each lot of plants was obtained by multiplying the number of plants in each disease category by the category number and dividing the sum by the total number of plants.

The disease ratings are given in Table 1. The pathogenicity of the different isolates as measured by their disease indices on onion seedlings varied from slight or none to severe.

A summary of the results in Table 1 are as follows: 1 to 25 percent infested roots, 34 lots; 26 to 50, 13 lots; 51 to 75, 21 lots; 75 to 100, 23 lots. There was a fairly even representation in each of the four disease categories. A high disease index was usually associated with a low number of surviving seedlings and reduced green weights. One culture produced no pink root. Among the hundreds of cultures used in the pink root studies over a period of several years an occasional culture was found that was typical of Pyrenochaeta terrestris but did not cause any pink discoloration on onion roots.

The variation in pathogenicity may be accounted for by assuming that there were mutations in the parent strains that gave rise to variants more pathogenic or less pathogenic than the

[4] Formula for Hoagland's solutionused by Gorenz, Larson, and Walker (5): 0.005 M $Ca(NO_3)_2$, 0.005 M KNO_3, 0.002 M $MgSO_4$, 0.001 M KH_2PO_4, 0.001 M NaCl, traces of H_3BO_3, $CuCl_2$, $ZnCl_2$, $MnCl_2$, $FeCl_3$.

Table 1. Variation in pathogenicity among 91 isolates of Pyrenochaeta terrestris from a single field.

Isolate number	Disease index	Isolate number	Disease index
1	35.7	47	94.1
2	93.6	48	74.2
3	86.6	49	45.5
4	87.0	50	100.0
5	43.3	51	25.0
6	53.4	52	43.1
7	66.9	53	25.0
8	79.4	54	50.0
9	50.0	55	69.6
10	83.9	56	97.0
11	55.8	57	58.1
12	25.0	58	25.0
13	100.0	59	25.0
14	37.5	60	25.0
15	25.0	61	68.6
16	25.0	62	18.1
17	62.9	63	49.1
18	25.0	64	90.9
19	25.0	65	25.0
20	91.7	66	100.0
21	25.0	67	100.0
22	100.0	68	25.0
23	28.8	69	25.0
24	75.0	70	65.0
25	0.0	71	32.0
26	25.0	72	14.6
27	25.0	73	25.0
28	100.0	74	50.0
29	58.7	75	87.5
30	67.5	76	25.0
31	25.0	77	25.0
32	69.0	78	5.6
33	25.0	79	100.0
34	78.6	80	25.0
35	87.2	81	100.0
36	25.0	82	96.6
37	25.0	83	34.2
38	51.7	84	25.0
39	25.0	85	100.0
40	25.0	86	100.0
41	51.4	87	25.0
42	57.5	88	25.0
43	25.0	89	25.0
44	68.8	90	39.3
45	71.5	91	100.0
46	69.2	Uninoc. Ck.	0.0

strains from which they arose. Gasiorkiewicz et al. (4) treated isolates of Pyrenochaeta terrestris with nitrogen mustard and thereby produced mutants which were either more virulent than the untreated controls or less virulent. These workers suggested that since most of the induced mutants fell within the natural range of variability of Pyrenochaeta terrestris, the variation among strains found in vivo might be due to the spontaneous mutation of presently existing strains. This might account at least in part for the wide variation in pathogenicity found among the 91 isolates used in the present study and among isolates of the pink root fungus from a wide geographical area.

PYCNIDIAL PRODUCTION

In our preliminary studies with a number of isolates on potato-dextrose agar and corn meal agar, no pycnidia were produced. In a later test, ten isolates were grown on Difco beanpod agar, fresh beanpod agar, and cut beans sealed in tubes. The cultures were placed in a 27° C incubator for 39 days and then examined for the presence of pycnidia. Two of the isolates produced pycnidia on the Difco beanpod agar, one on the fresh beanpod agar, and none of them produced pycnidia on the cut beans.

Beanpod agar prepared after the method of Edgerton (2) was placed in test tubes and slanted. The slants were inoculated with the nine isolates and stored for 57 days in a 27° C incubator. The cultures were then examined under a binocular dissecting microscope for the presence of pycnidia. The results are presented in Table 2. Since the majority of the 91 isolates did not produce pycnidia, only those that did produce pycnidia or pycnidium-like bodies are included in the table.

Table 2. The 18 isolates that produced pycnidia or pycnidium-like bodies, and their disease index.

Isolate number	Replication 1	2	3	Disease index[a]
1	PL[b]	O[c]	O	35.7
2	PL	O	O	93.6
7	P[d]	P	P	66.9
8	PL	PL	PL	79.4
13	P	P	O	100.0
19	P	P	O	25.0
32	PL	O	O	69.0
50	PL	O	O	100.0
53	P	P	P	25.0
55	PL	PL	O	69.6
66	PL	PL	PL	100.0
67	P	O	O	100.0
69	P	P	P	25.0
79	PL	O	O	100.0
81	P	P	O	100.0
83	PL	O	O	34.2
86	PL	O	O	100.0
91	P	P	P	100.0
			Mean	73.5

[a] Data from a previous test.
[b] Pycnidium-like bodies.
[c] No pycnidia or pycnidium-like bodies.
[d] Pycnidia.

As shown in Table 2, 8 of the 91 isolates produced true pycnidia and 10 produced pycnidium-like bodies. These bodies were characterized by absence of spores and setae and they were somewhat smaller than true pycnidia and were not erumpent. The isolates produced either pycnidia, pycnidum-like bodies, or no pycnidia or pycnidium-like bodies. In no case did any one of the isolates produce both pycnidia and pycnidium-like bodies.

The mean disease index rating for the 18 isolates which produced pycnidia or pycnidium-like bodies was 73.5. This figure is much higher than that for the 91 isolates taken collectively, namely 53.1, and also greater than 48.1, the mean for the 73 isolates that did not produce pycnidia or pycnidium-like bodies. The results of this study indicate that there was an apparent correlation between the production in vitro of pycnidia or pycnidium-like bodies by these isolates of Pyrenochaeta terrestris and their ability to produce pink root of onion seedlings.

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INTERNAL BREAKDOWN IN CROWN OF RED CLOVER

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Abstract

An internal breakdown (IB) of the crown of red clover was found in all fields observed from Maine to Virginia. Necrosis occurs first as a small, dark, watery area in the pith of the crown when plants are approximately 3 months old. As plants mature, incidence of IB increases and affected areas enlarge and later become corky and dry. In the greenhouse the incidence of IB increased from 23 percent of the plants at the end of 12 weeks to 72 percent at the end of 41 weeks. No organism was consistently associated with IB. Possible influence of minor elements on the incidence of IB is discussed.

Failure of red clover stands has been attributed to various disorders. The nebulous term "crown and root rot complex" has been applied to one of these conditions (1, 2). The problem has been investigated by collecting diseased plants from fields and culturing discolored tissues for presence of fungi. Common soil fungi, primarily Fusarium spp., were generally recovered. While some of the fungi were pathogenic to seedlings, field symptoms in older plants were rarely duplicated. In some cases no organism was recovered from internally discolored crown tissues. In addition, the internal discoloration did not always extend to an external injury or lesion.

In a recent study concerning a possible disease-insect relationship in red clover an internal discoloration of the crown was found in all treatments (1). Subsequently, tests herein reported were conducted to determine the cause, development, and distribution of internal breakdown (IB) in the crown of red clover.

MATERIALS AND METHODS

In September 1958, 630 four-inch pots were filled with three different soils, 385 with potting soil at pH 7.0 and high in phosphorus and potassium, 165 with Hagerstown silt loam at pH 5.8 obtained from a field where IB was present, and 80 with Morrison loam at pH 6.3, high in phosphorus and low in potassium. The pots were seeded with Pennscott red clover, and after emergence the plants were thinned to one per pot. Plants were grown in a greenhouse at approximately 20° C and the daylength was extended to 15-1/2 hours during the winter except as otherwise indicated. The plants in the potting soil were divided into groups of 55 each and treated as follows: 1) 100 ml of nutrient solution added to soil approximately every 2 weeks (composition of nutrient solution in ppm was Ca 100, K 101, N 98, Mg 24, S 32, P 19, Mn 0.98, B 1.16, Cu 0.16, Zn 0.10, Fe 3.50, and Mo 0.02); 2) no supplementary light; 3) low temperature (approximately 12° C until late spring) and no supplementary light; 4) shaded and held in a rooting chamber (no supplementary light); 5) plants inoculated with red clover vein mosaic and bean yellow mosaic viruses; 6) plants inoculated (spore and mycelial suspensions poured onto cut rootlets) with isolates of Fusarium spp. from red clover; and 7) control.

Plants in unsteamed Hagerstown silt loam were also divided into groups of 55 and subjected to the following treatments: 1) 50 ml of 5 ppm boron solution applied to the soil every 2 to 3 weeks; 2) 50 ml of minor-element solution at twice the concentration used in the above nutrient solution applied to the soil every 2 to 3 weeks (as the plants enlarged the concentration was increased accordingly); and 3) control.

Twenty of the plants in unsteamed Morrison loam received potassium chloride solution (100 ml of 400 ppm K) at 2-week intervals and the remaining 60 plants received no further treatment.

Three months after seeding and thereafter at 3-week intervals, five plants given each treatment were removed, washed, and examined for IB. Root diameter and size of IB areas were measured. Isolations were made from internal crown tissues surface-disinfected with

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calcium hypochlorite or mercuric chloride or with the outer crown tissues peeled with sterile forceps and pieces transferred directly to "V8 juice" agar.

RESULTS AND DISCUSSION

The first symptoms of internal breakdown were small, dark, watery necrotic areas in the pith of the crown, when plants in the greenhouse and field were about 3 months old (7-to 10-mm root diameter). The number of crowns affected and the size of the affected areas increased with age of plants. No external symptoms were visible. The necrotic tissue in older plants (Fig. 1) became corky and dry and was not generally traceable to the exterior of the crown. In the greenhouse, however, some 6-month-old plants exhibited necrotic areas that were contiguous to old cut stems. In the field, IB extended to outside rots and injuries earlier than in the greenhouse.

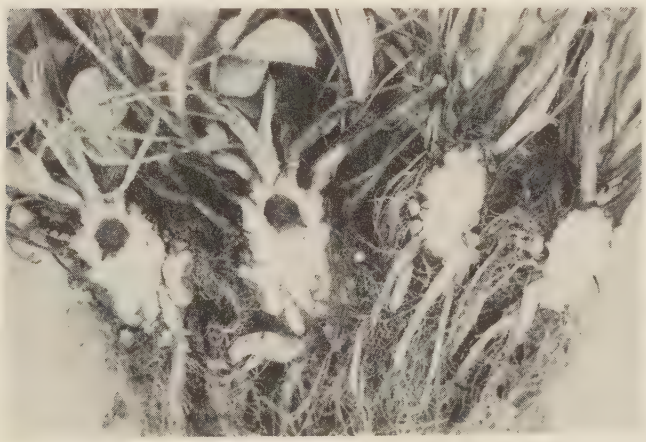

FIGURE 1. Left -- internal breakdown in crown of red clover. Right -- healthy crown.

Numerous isolations were made from the internal necrotic and adjacent tissues, but no pathogen was consistently recovered. Often no organism was isolated from small IB areas. When organisms were recovered, however, bacteria and Chaetomium sp. accounted for almost one-half of the isolates from tissue pieces obtained from greenhouse plants but fewer than this from field plants. As IB progressed, one or more of the following organisms, in addition to the above, were frequently isolated: Fusarium spp., Phoma spp., and Rhizoctonia solani Kuehn. The same organisms were sometimes recovered from crowns showing no IB or other symptoms of disease. Attempts to produce IB artificially by inoculation of roots and crowns with fungi, bacteria, or ground IB tissues were unsuccessful. Internal breakdown incidence was no greater in plants inoculated with red clover vein and bean yellow mosaic viruses than in noninoculated plants.

Considering all treatments in the greenhouse experiment, IB was detected in 23 percent of the plants (root diameter approximately 10 mm) when plants were 12 weeks old. At the end of 41 weeks the percentage was 72, and the necrotic areas ranged from 2 x 2 mm to 7 x 16 mm in size. Root diameters ranged from 9 (Hagerstown soil) to 19 mm (greenhouse potting soil, no supplementary lights). The only treatment which consistently reduced the incidence of IB was the addition of a high concentration of minor elements to plants grown in Hagerstown silt loam. Only 20 percent of the plants that received minor elements exhibited symptoms of IB as compared with 60 percent of the plants in untreated Hagerstown soil. Addition of boron reduced the incidence of IB slightly, but it was not consistently as effective as the complete minor-element treatment. Plants grown in the Hagerstown soil were smaller than those grown in the other two soils, possibly because of the poorer physical condition of the Hagerstown soil.

Plants showed no macroscopic deficiency symptoms or growth response to minor elements. This suggests that the minor-element effect, if substantiated by additional research, may not be due to overcoming a deficiency but rather to some unknown indirect effect. A high concentration of minor elements may be necessary to reduce IB incidence since plants in the potting soil receiving a moderate level of minor elements had as much IB as those in the control treatment. This was also indicated by the fact that IB occurred in all red clover fields observed from Maine to Virginia. That a minor element is so widely deficient in red clover fields is unlikely.

IB was not restricted to the red clover variety Pennscott. Dollard, Midland, and Lakeland red clover varieties were also tested and IB was found in all varieties after 4 months. The incidence of IB was lower in Lakeland than in the other varieties.

The results of the present study suggest that IB is a physiogenic disease of widespread occurrence and of unknown economic importance. Studies are being continued on the role of minor elements and other factors on the occurrence of IB and the effect of the breakdown on longevity of red clover.

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NOTES ON TOBACCO DISEASES IN COLOMBIA, SOUTH AMERICA

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Summary

The major diseases of tobacco in Colombia are mosaic, leaf curl, black shank, frogeye, and brown spot. Previously, leaf curl in the New World was recognized as occurring only in Venezuela.

Recently the author was afforded an opportunity to observe the diseases occurring in several Departments (States) of Colombia, especially in Antioquia, Bolivar, Caldas, Santander, and Tolima. In each of these Departments black tobaccos, used in the manufacture of black cigarettes and cigars, have long been cultivated, first by the Indians and for several centuries subsequently by the Spanish. A number of different varieties are being grown, some of which are manifestly native or criollo kinds that have been maintained with little change for several hundred years. Other varieties have been introduced from the West Indies, Central America, and nearby Latin-American countries. No one can now be certain as to which diseases are indigenous and which ones were introduced with the tobacco seed from sources outside of Colombia.

Among the diseases of major importance encountered were ordinary mosaic, leaf curl (Kroepoek, encrespamiento de las hojas, or enroscamiento del cogollo), black shank, frogeye, and brown spot. There are reasons for believing that the first three of these diseases are indigenous, partly because it has been established that none of them is seed-borne. However, the fungi that cause frogeye and brown spot have been demonstrated to adhere externally to the seed, hence are seed-borne.

In the light of a previous report (3) regarding tobacco diseases in Venezuela it becomes of more than passing interest to the tobacco industry to learn more of the diseases of this crop in other parts of South America, hence the following brief account.

Mosaic: Ordinary mosaic is universally present in all tobacco fields. Such incidence and distribution may be accounted for by the facts that 1) black tobaccos are air-cured, the virus thus remaining infectious in the cured leaf; and 2) after the principal crop has been harvested, the stalks are cut off and one or two crops of suckers are permitted to develop, the leaves of of which are, in turn, harvested. These practices encourage the spread of mosaic to the extent that all sucker leaves may become affected. The mosaic-resistant variety Ambalema, from the environs of the town of the same name in the Cauca Valley, is not widely cultivated. But, as is well known, mosaic yields readily to control by the employment of sanitary measures in the management of the seedbeds and fields.

Leaf Curl: As shown by Wolf, Whitcomb, and Mooney (4) leaf curl was first recognzied as occurring in the New World, in Venezuela, although it had long been known to occur in Africa, Indonesia, and India. It is of interest to note that subsequently no one has reported leaf curl in other South American countries; the writer had suspected, however, that such was the case. Leaf curl was observed in Colombia in all tobacco fields in the Departments of Antioquia, Bolivar, Caldas, Santander, and Tolima. No doubt it has been present throughout Colombia for years. Moreover, it is very probable that the disease is widely prevalent in other tobacco-growing countries of South America. This disease in Indonesia and Venezuela has been shown to yield to control measures that are designed to eliminate whiteflies, the vectors of the virus that causes leaf curl.

Black Shank: This disease, known in Colombia as pata prieta (darkened foot), is caused by one or more of several races or varieties of Phytophthora parasitica Dastur. All of them attack field-grown plants near the soil level, from which point the pathogen advances upward in the stem and downward in the roots, killing the invaded tissues. Black shank seldom reaches epiphytotic proportions in regions having hot, dry weather. Hence in fields in the Tropics having infested soils, only occasional plants, quite widely separated, succumb, rather than essentially all plants in areas having infested soils. No evidence of tolerance to black shank among black tobaccos is at hand.

Frogeye: Frogeye was not seen on black tobaccos, but only on flue-cured varieties being grown for the first time in Tolima. These fields previously had never been planted to tobacco. It is reasonable to suspect that the causal fungus, Cercospora apii Fr., was introduced into the seedbeds with the seed and that the pathogen was present on the seedlings at time of transplanting.

The conidia of this fungus have been demonstrated to adhere to the seed, and thus the pathogen is seed-borne and therefore is provided with a means for initiating the disease in the seedbeds.

Hopkins (2) demonstrated that the conditions most favorable for frogeye are 1) over-ripeness of the leaf, 2) delayed harvesting due to nitrogen deficiency, and 3) periods of wet weather during the harvesting season.

Brown Spot: Brown spot, also called Alternaria spot, is caused by Alternaria longipes (Ell. & Ev.) Mason. This disease was noted only on flue-cured tobacco. Gulyás (1) established that the brown spot fungus is seed-borne. It produces lesions on the stems, leaves, and capsules. Completely effective elimination of Alternaria has been shown by Hopkins (2) to occur when the tobacco seeds were treated with a 1:1000 solution of silver nitrate.

Brown spot has caused severe epiphytotics in certain regions, as in the countries of southern Africa. It is generally regarded as a disease that appears only late in the development of the tobacco plant, at which stage during periods of relative high humidity it may become very destructive.

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POSTHARVEST FUNGICIDE TREATMENTS FOR REDUCTION OF DECAY IN ANJOU PEARS

C. F. Pierson[1]

Summary

Four fungicides were used in postharvest treatments of Anjou pears. Captan, Phaltan, and Stop-Mold were about equally effective in the control of decay, while dehydroacetic acid was less effective.

Postharvest fungicide treatments are advisable for Anjou pears, particularly those packed in polyethylene box liners, because the high relative humidity favors the development of decay (3). English (1) and Kienholz, et al. (2) reduced the amount of decay in apples and pears with sodium chloro-2-phenylphenate. However, it caused a dermatitis on some packinghouse workers, and was replaced by sodium-o-phenylphenate, which is less toxic to personnel. Stop-Mold, a commercial formulation containing the latter material, has been used extensively in the Northwest to reduce postharvest rots in apples and pears. Many packers are dissatisfied with it because fruit is injured if treatment is not followed by a rinse, and rinsing reduces the effectiveness of the fungicide.

In 1955 laboratory assays based on inhibition of spore germination were started to find materials which might be superior to the fungicides then in use in the packing industry. Fifteen materials were assayed, and three of the more promising ones were selected for further testing on fruit.

MATERIALS AND METHODS

Orchard-run Anjou pears from a commercial warehouse were composited into samples after fruits with punctures and other obvious blemishes had been removed. Three boxes of fruit per treatment were used each year. The materials and concentrations of active ingredient for the treatments were as follows: Check fruit dipped in clear water; captan (n-trichloromethylmercapto-4-cyclohexene-1,2), 0.12 percent (1 pound/100 gallons); Phaltan (n-trichloromethylthiophthalimide), 0.12 percent; DHA-S (dehydroacetic acid-sodium salt) 1 percent; Stop-Mold (Sodium-o-phenylphenate), 0.6 percent, the latter followed by a clear water rinse. All fruit was wrapped in copper-impregnated paper (Hartman wraps) and was stored in sealed polyethylene box liners. Segregations for decay were made following 150 days at 31° F, and again after ripening for 7 days at 65°.

RESULTS

The mean percentages of decay for the 3-year period were as follows: Check 34.6; captan 15.8; Phaltan 18.4; Stop-Mold 17.5; and DHA-S 25.1 (Table 1). At the 1-percent level there

Table 1. Effect of postharvest fungicides on the decay of Anjou pears after 150 days at 31° and 7 days at 65° F.

Treatment	Percent decay			
	1956	1957	1958	Mean
None - Check	28.4	28.9	46.7	34.6
Captan	15.4	11.0	21.1	15.8
Phaltan	21.1	10.4	23.9	18.4
Stop-Mold	20.4	15.8	16.3	17.5
DHA-S	22.4	16.8	36.1	25.1
LSD (0.05)	8.77			
LSD (0.01)	12.26			

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was a significant difference between the amount of decay in the checks and in the lots treated with captan, Phaltan, and Stop-Mold. At the 5-percent level there was significance between the amount of decay in the checks and the lots treated with DHA-S.

DISCUSSION

Captan, Phaltan, and Stop-Mold appear to be about equally effective in controlling postharvest decays of Anjou pears, while DHA-S is less so. The relative ineffectiveness of DHA-S eliminates it from further consideration.

Captan and Phaltan have similar characteristics. Both are insoluble in water and are formulated as wettable powders, hence a mechanical agitator would have to be used in the wash tank to keep the material in suspension. Both are less expensive than Stop-Mold, and may be used without a rinse, since neither one causes chemical injury at the recommended concentration. No residue tolerance has been established for Phaltan in postharvest applications so it can not be used commercially.

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A PHOMOPSIS STEM BLIGHT OF YELLOW LUPINE (LUPINUS LUTEUS L.)[1]

Stanley A. Ostazeski and Homer D. Wells[2]

Abstract

Stem blight of yellow lupine, caused by Phomopsis leptostromiformis (Kühn) Bubak, is reported and described as a hitherto unrecognized disease of yellow lupine in the United States. The disease has not been serious to date, but infected plants have been found in fields in Georgia and Florida. Yellow and white lupines were susceptible in greenhouse tests, while blue lupine was apparently immune. The fungus is seed-borne and can persist in seed for at least 2 years.

During the winters of 1954-55 and 1955-56 a disease on yellow lupine, Lupinus luteus L., apparently new to the United States, was recognized in nursery plantings at Tifton, Georgia. Symptoms consisted of gray to light tan, bleached-out, linear stem cankers varying in length from less than 1/2 to more than 3 inches. Lesions were usually sunken and dried out in appearance. Larger lesions usually girdled and killed the stem. Black pycnidia of a species of Phomopsis could usually be found in lesions 1 inch or more in length (Fig. 1).

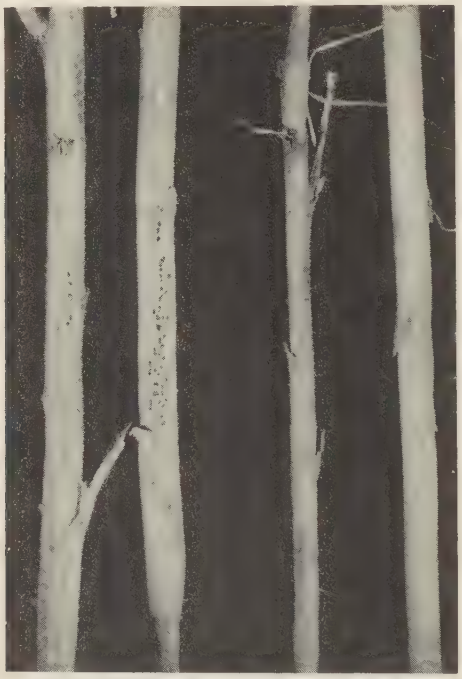

FIGURE 1. Stems of yellow lupine showing varying degrees of infection by Phomopsis leptostromiformis.

The fungus and symptoms it produced closely resemble those associated with a lupine disease occurring in Poland called "patchiness of lupine stems." Kochman (3) and others demonstrated the pathogenicity of Phomopsis leptostromiformis (Kühn) Bubak.

The fungus was readily isolated from surface-sterilized, diseased tissue plated on various agar media. However, isolates did not fruit on any medium unless small pieces of sterilized plant tissue were present. Fruiting bodies were produced on stems of alfalfa, sweetclover, barley, white lupine, blue lupine, yellow lupine, and ryegrass seed. Both propylene oxide gas

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[1]Cooperative investigations at Gainesville, Florida and Tifton, Georgia, of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, the University of Florida Agricultural Experiment Station, and the University of Georgia, College of Agriculture Experiment Stations, Georgia Coastal Plain Experiment Station. University of Florida Agricultural Experiment Station Journal Series, No. 1008.

[2]Plant Pathologists, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, Gainesville, Florida and Tifton, Georgia, respectively.

and autoclaving were effective in sterilizing plant materials used in agars. Fruiting bodies formed on such sterilized tissue proved to be those of a species of Phomopsis.

Alpha spores from pycnidia on naturally infected stems measured 6.8-10.2 x 1.5-2μ (mean 8.5 x 1.7μ). Filiform stylospores (beta conidia) were not observed. The characteristics of the fungus correspond to those cited by Grove (2) for P. leptostromiformis on dead petioles and stems of L. polyphyllus Lindl. and L. arboreus Sims. Therefore, it is the opinion of the authors that the Phomopsis disease of yellow lupine reported herein is identical with the one reported from Europe.

Characteristic symptoms were produced on plants of yellow and white lupine (L. albus L.) when pieces of toothpick containing the fungus were inserted into the lower stem. Blue lupine (L. angustifolius L.) was not infected by this method (1).

Since the initial discovery at Tifton, Georgia, the disease has been observed near Albany, Georgia, in the spring of 1957, and in 1958 at Alachua and Ocala, Florida. To date, the disease has not become serious in commercial fields; usually, less than 1 percent of the plants in a field were diseased. In several cases, new infestations resulted when seed was obtained from diseased fields. Suspected seed transmission was confirmed when the fungus was isolated from seed harvested from infested fields in 1956. Isolations from the same seed lot in 1957 and again in 1958 suggest that the organism persists in seed for at least 2 years.

It is proposed that the lupine disease caused by P. leptostromiformis be called "stem blight."

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UNITED STATES DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE; UNIVERSITY OF FLORIDA AGRICULTURAL EXPERIMENT STATION; AND UNIVERSITY OF GEORGIA COASTAL PLAIN EXPERIMENT STATION

SCREENING OF POTATO FUNGICIDES IN 1959[1]

L. C. Callbeck[2]

In 1959, thirteen fungicides for potato late blight (Phytophthora infestans (Mont.) de Bary) were included in the Screening Test conducted in Canada at the Research Laboratory, Charlottetown, Prince Edward Island. These fungicides were:

1. CD-1465 -- An experimental fungicide developed by Ludwig and Thorn at the Pesticide Research Institute, London, Ontario.
   Concentration: 6 quarts + 1.3 pounds of zinc sulfate per 80 Imperial gallons.

2. Colloidox -- A colloidal copper product containing 20 percent copper.
   Concentration: 2.5 pounds-80.
   Source: Agricola Limited, London, England, and received from Green Cross Products.

3. EF35429 -- Chemical composition not released.
   Concentration: 2 pounds-80.
   Source: American Cyanamid Company.

4. GC-2466 -- Mucochloric anhydride or bis-(3,4,dichloro-2(5)-furanonyl ether.
   Concentration: 1.5 pounds-80.
   Source: General Chemical Division, Allied Chemical Corporation.

5. LO-1499 -- Ammonium ethylene bisdithiocarbamate.
   Concentration: 1 quart + 1 pound zinc sulfate-80.
   Source: Rohm and Haas Company.

6. LO-1769 -- Chemical composition not released.
   Concentration: 1.5 pounds-80.
   Source: Rohm and Haas Company.

7. LO-1769 Sp. T. M. -- Chemical composition not released.
   Concentration: 1.5 pounds-80.
   Source: Rohm and Haas Company.

8. N-2038 -- Chemical composition not released.
   Concentration: 1.5 pounds-80.
   Source: Rohm and Haas Company.

9. NPH64 (Tubosan) -- 15 percent ziram; 33 percent copper as basic copper sulfate.
   Concentration: 2 pounds-80.
   Source: May and Baker (Canada) Limited.

10. 03818-B -- Nickel ethylene bisdithiocarbamate and zineb.
    Concentration: 3.5 pounds-80.
    Source: Rohm and Haas Company.

11. Phaltan -- N-trichloromethylthiophthalimide.
    Concentration: 2 pounds-80.
    Source: Stauffer Chemical Company, and received from Chipman Chemicals Limited.

12. Phygon -- 2,3,dichloro-1,4-naphthoquinone.
    Concentration: 0.5 pounds-80.
    Source: Naugatuck Chemicals.

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[1] Contribution No. 58, Research Laboratory, Research Branch, Canada Department of Agriculture, Charlottetown, Prince Edward Island.
[2] Plant Pathologist.

Bordeaux mixture, 8-4-80, as in all years, as the standard fungicide, and an unsprayed control were included. There were fourteen sets of plots in all.

The plots were planted on June 12, and the Green Mountain seed pieces were counted to assure the same number in each row. Each plot was 4 rows wide by 50 feet long; and fifteen plots, one for each treatment, were planted in each of four ranges. Single rows of potatoes were used as borders and buffers, and, because these rows were not sprayed, they served as sources of late blight infection. All data were taken from the two center rows.

The sprays were applied with an experimental tractor-sprayer unit, custom built for the work. The nozzles were so placed on the boom that each row received a 4-nozzle spray, and

Table 1. Percentage defoliation caused by late blight.

Treatment	Sept. 4	Sept. 10	Sept. 18
LO-1499	4	11	18
Phaltan	4	12	25
03818-B	4	13	28
Bordeaux	4	15	35
LO-1769 Sp. T. M.	7	20	37
N-2038	6	25	44
NPH64	7	25	58
LO-1769	10	35	66
Phygon	9	37	75
Colloidox	14	55	88
GC-2466	18	77	98
EF35429	19	86	100
CD-1465	29	94	100
Check	48	100	100

Table 2. Effect of treatments on yield and on late blight tuber rot.

Treatment	Total Bu/A	Smalls Bu/A	Rot Bu/A	No. 1 Bu/A	Percent rot
LO-1499	273.5	20.9	8.8	243.8	3.2
Phaltan	274.6	30.4	8.8	235.4	3.2
03818-B	277.2	31.0	17.4	228.8	6.3
Bordeaux	272.8	27.3	16.4	228.8	6.1
N-2038	258.5	30.8	9.2	218.5	3.6
LO-1769 Sp. T. M.	255.9	29.3	9.9	216.7	3.9
NPH64	259.2	36.0	21.2	202.0	8.2
Phygon	221.1	31.0	23.3	166.8	10.5
LO-1769	221.1	33.0	24.2	163.9	10.9
Colloidox	222.6	29.0	30.1	163.5	13.5
GC-2466	196.9	29.7	23.1	144.1	11.7
CD-1465	185.5	26.0	45.1	114.4	24.3
EF35429	191.0	35.2	52.8	103.0	27.6
Check	160.2	30.4	59.4	70.4	37.1
S.D. 5%	25.6			32.5	13.2
S.D. 1%	34.3			43.5	17.7

the machine was set to operate at a pressure of 375 pounds per square inch. All rows were sprayed with DDT on July 17 and with malathion on August 13. The fungicides were applied July 16, 27, August 7, 17, 26, September 3, 10, the intervals being 11, 11, 10, 9, 8, 7 days.

Late blight lesions were present in the buffer rows and check plots on August 13 and in less than 4 weeks these unsprayed plants were completely defoliated. Differences in the efficiency of the several fungicides soon became apparent.

Although it was a "wet" season, the rainfall was considerably below average. The precipitation at Charlottetown for the July-September period was only 7.03 inches or 3.33 inches below the 38-year mean. However, there were 45 days in which rain fell and, although many of these rains were unrecorded traces (mists), the relative humidity was often high for long periods. From August 4 to August 11 some rain or drizzle fell each day and the mean relative humidity for the period was 93.1 percent. There were five wet days during the weeks of August 12-18 and the mean relative humidity was 87.6 percent. The last week of August and the first week of September were also wet and the mean relative humidities were 85.1 and 81.0 percent respectively.

The rapid progress of the disease, caused by the free moisture and high relative humidity, made it possible to compare the fungicides under ideal test conditions.

Defoliation readings were taken at regular intervals, and the mean defoliations for selected dates, expressed as percentages, are given in Table 1.

On September 21, or 101 days after planting, the plots that had not been killed by disease were sprayed with a solution of sodium arsenite to destroy the remaining foliage. Two weeks later the tubers were lifted, graded, weighed, and examined for late blight rot. The results are presented in Table 2.

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A BARLEY LOOSE SMUT EPIDEMIC IN MINNESOTA IN 1959[1]

K. D. Fezer and H. G. Johnson[2]

The loss due to loose smut of barley in the Red River Valley area of Minnesota was estimated to be 1 to 2 percent of the crop in 1958. A more severe epidemic developed in 1959; conservative calculations of losses due to loose smut in Minnesota alone -- ignoring important barley areas in adjacent States -- exceed $1.5 million.

In order to evaluate the loss, healthy and smutted heads were counted in each of three or more yard-long lengths of drill row in each of 63 barley fields scattered throughout the area. An additional 66 fields were sampled in a similar manner by county agents. These 129 fields had an average of 6.4 percent of heads with loose smut, with a range from 0 to 30 percent. Reports of two fields with 40 to 45 percent of the plants infected were received, as well as reports of at least one farmer who plowed his barley down because of loose smut.

Germination of chlamydospores indicated that semi-loose smut comprised a very small part of the smut observed; of 43 smutted heads collected from 26 fields, 41 were infected with Ustilago nuda (Jens.) Rostr. and only two with U. nigra Tapke. Both of these heads occurred in fields with little smut.

Of the 129 fields surveyed, 48 were identified as Traill barley, 18 as Kindred and 16 as Forrest. (Most of the remaining fields consisted of the same varieties, but were not individually identified.) Fields of these three varieties had averages of 8.4, 4.7, and 6.1 percent heads infected, respectively. Of fields in which the barley variety was identified, the three with over 20 percent loose smut were Traill. But many fields of all three varieties were low in smut, including some with a trace or none. At present there is no evidence to account for differences in incidence of loose smut among these three varieties.

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"HOJA BLANCA" DISEASE OF RICE IN GUATEMALA

Eugenio Schieber and Oscar Nery Sosa

The "hoja blanca" virus disease of rice was found for the first time in eastern Guatemala, on local varieties and a field of the variety "Century." Especially severe attacks showing typical symptoms as described before from Venezuela and Cuba[1], were found in the Quezada area in the Department of Jutiapa and near the border of another Central American country, El Salvador, where the disease has spread rapidly since it was first reported there.

Symptoms show the characteristic white stripes on the leaf blade, particularly the one adjacent to the panicle. Panicles are somewhat reduced in size and empty (sterile). Some of the diseased plants are reduced in height. Symptoms of "hoja blanca" and those described for the "stripe virus disease" in Japan are very similar, as noted by some workers previously. No nematodes were found upon examination of the root systems.

Leafhoppers were present in large amount where the disease appeared to be more severe.

Attempts to control the disease through the introduction of resistant varieties are under way, with the cooperation of experiment stations in Texas, Arkansas, Venezuela and Costa Rica.

INSTITUTO AGROPECUARIO NACIONAL, GUATEMALA, GUATEMALA C. A.

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CYTOSPORA CANKER OF ENGELMANN SPRUCE IN COLORADO

Frank G. Hawksworth and Thomas E. Hinds[1]

A comparative study on Valsa (Cytospora) kunzei cankers on conifers in northeastern United States has been made by Waterman[2]. Recently Wright[3] reported that the pitch-girdle canker of Douglas-fir in central Colorado is also caused by C. kunzei. This note describes for the first time the disease on Engelmann spruce, Picea engelmanni. It was found in 1959 in a spruce stand near Kenosha Pass, Pike National Forest, Colorado.

The disease is characterized by copious resin flow, particularly from main-stem infections. Definite diamond-shaped cankers are revealed as black, necrotic inner bark when the outer bark is removed. Fruiting bodies of both the Valsa and Cytospora stages of the fungus were present on the cankers in June. However, the Valsa stage was immature, so the variety of V. kunzei as classified by Waterman[2] could not be determined.

The single infection center observed covered about 1/3 acre and included 27 diseased trees. Trunk and branch infections were common on trees up to about 6 inches in diameter, while only branch cankers were noted on larger trees. Five spruce poles averaging about 5 inches in diameter were recently killed by the disease.

The reports in the literature[2, 3] indicate that Cytospora canker is usually a secondary disease that infects trees weakened by drought, fire, insects, or unfavorable environmental conditions. In this instance, hail-damage from a storm in about 1955 was severe, and this may have been a factor predisposing the trees to the fungus.

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[1]Plant Pathologists, Rocky Mountain Forest and Range Experiment Station, Forest Service, United States Department of Agriculture, with central headquarters at Fort Collins, Colorado, in cooperation with Colorado State University.

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OCCURRENCE OF VERTICILLIUM WILT ON RUSSIAN OLIVE[1]

T. E. Smith[2]

Russian olive (Elaeagnus angustifolia) had symptoms of a vascular disease in a nursery planting of a thousand plants in the Mesilla Valley of New Mexico. The planting was located in an area generally infested with Verticillium and the particular site was planted to cotton in 1957 prior to establishment of the Russian olives in March 1958. The plants were 3 to 6 feet high and nearly all were diseased by September 1958. External symptoms included localized leaf yellowing in the early stages followed by flagging of branches and defoliation. By October 1959 a 10 percent kill had occurred. Internal symptoms included brown stippling and bands of brown discoloration in the stele.

Tissue plantings of discolored stele from Russian olive gave the microsclerotial type of Verticillium albo-atrum Reinke & Berth. on potato-dextrose-carrot agar. Inoculations were made on young plants of 1517C cotton by dipping their roots in diluted, macerated cultures increased on sterilized oats, using three isolates from Russian olive and other isolates from cotton. Typical Verticillium symptoms occurred on the inoculated cotton within 14 days with all isolates. Standard host lists contain no reference to Verticillium on Russian olive, and the high susceptibility of this species to natural infection presents a hazard to its use in wind-breaks and for ornamental purposes.

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